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Thesis

THE MIMEOGRAPH DUPLICATOR
A TOOL OF PRODUCTION CONTROL

by

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(B.S. Yale University 1935)

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the requirements for the degree of

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Chapter I

Development of the Mimeograph Process

1. History of the A.B.Dick Company

In 1886, a young man by the name of Albert Blake Dick, working in the office of a lumber company in Chicago, needed some way to reproduce price lists. As it was, he seemed to spend most of his time copying them over and over again. Young Dick tried many experiments with different kinds of paper and different writing implements, and finally, one day his answer came almost by accident with a new pair of shoes. Laying the tissue paper in which they were wrapped over a flat file[1] and scratching on it, he was able to produce a series of holes in the paper.

Later, he found that by using a sheet of waxed paper laid on the file and drawing an awl over it, he was able to produce a like series of perforations along the line traversed and still retain the strength of the paper. And so he began his development of the stencil duplicating process for modern business.

After some further experimentation, he developed a saw-toothed writing plate which he used instead

1. Some confusion exists over the kind of file that was used, but it is presumed it was an ordinary file such as was used by blacksmiths for filing horse-shoes.

of the file. With this he produced his first stencil by laying the sheet of waxed paper over the plate and writing on it with the awl. The stencil was then laid over a sheet of blank paper and an inked roller was rolled over the surface of the stencil. The ink was squeezed through the small openings in the paper and a copy was made on the blank paper underneath. The stencil was removed from the paper, placed over another sheet and the process was repeated for a second copy. In this way, Mr. Dick wrote his price list only once, and produced as many stencil duplicated copies as he needed from the single writing.

The lumber company put his device to good use and it soon became apparent that it could also be used in other businesses as well. While investigating the possibilities of a patent for his device, Mr. Dick became acquainted with Thomas Alva Edison who was also experimenting along the same lines. His invention, however, was considerably more complicated than Mr. Dick's. He had invented an electric pen which had a small motor on one end of it, and as it was drawn across the paper, it too made a series of minute holes in the paper. This,of course, was a much slower and more laborious way of making a stencil. So, the two men combined their ideas and the Mimeograph[1]

1. Mimeograph is a trade mark of the A.B.Dick Company

duplicator was born.

They coined the word Mimeograph from the Greek "mime" meaning to copy, and "graph", to draw. They added the "o" for euphony, and the word became the trade mark of the A.B.Dick Company.

2. Trend into Production Control

In the intervening years, the Mimeograph process has been steadily improved. Rotary type machines have followed the old flat-bed types. Automatic feeds and electric drives have been added. But still, the main uses for the machine were practically the same after fifty years, as they had been when it was first invented; forms, lists, bulletins, and letters, plus all the myriad duplicating jobs which did not necessarily require better registration than the machine was designed to give.

That is to say, each copy as it was delivered to the receiving tray would only be positioned within a typewriter space up or down from where the previous copy had been.

Then, about 1941, company engineers began to investigate possible uses of the equipment in factories in production control work. It is that development which will be discussed and explained in this thesis. It will be shown how improvements were made in the machine itself to produce the hair-line registration necessary in so many of these factory applications.

duplicator was born.

Changes made in the ink and stencils themselves, which were necessary to fulfill the requirements of this exacting new field will also be discussed. And finally, the changes in technique which had to be developed to weld all of these things into one new tool.

When all of these basic changes have been set down and explained, examples and test cases will be presented to show how they are being used in industry to help solve the various aspects of the problem of production control.

3. Apriori Assumptions

Despite discouraging reminders that these theses are seldom published, it is hoped that this one can be published and distributed among industrial engineers.

The apriori assumption behind it is that most industrial engineers are unaware of the possibilities of the Mimeograph duplicator as a production control tool. Different aniline die systems have been in use for many years now, and it is to these that the engineers naturally turn. Therefore, the main purpose of this thesis will be to show production engineers just how the Mimeograph can be, and is being used advantageously in production control systems.

Chapter II

The Machine and the Inks

1. The Machine

In this chapter, the Mimeograph duplicator, as it has been developed for all its various factory uses, and the special devices, which have been contrived to further its uses, will be described.

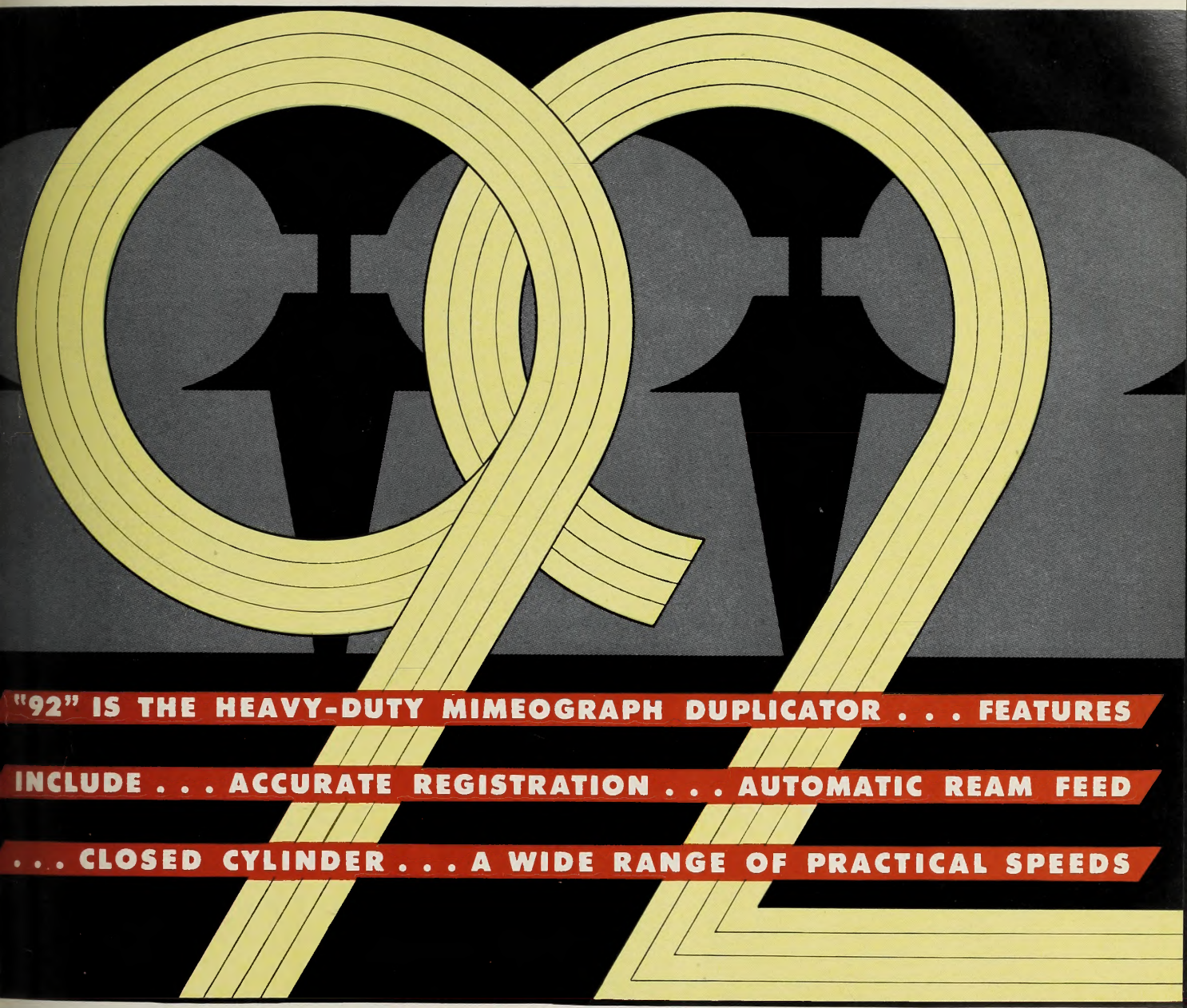
The machine (Figure 1) will handle all sizes of stock from three by five inch cards up to eight and one-half by sixteen inch legal size paper and up to five hundred sheets of this paper at one time. All of the various sizes of stencils, which will be described later, can, of course, be used on the machine, though some of the smaller ones require a mask to block off that part of the pad which they would otherwise leave exposed.

Due to a very positive control over the paper as it is fed automatically into the machine, a hair-line accuracy of the registration is assured. The print can be raised (that is, moved toward the top of the page) or lowered as much as ten typewriter spaces with a simple adjustment on the cylinder. It can also be moved as much as three quarters of an inch from one side to the other, and in case the stencil has been typed crookedly by accident, the copy, as it comes from the duplicator can be straightened on the paper.

Figure I

MIMEOGRAPH

Mimeograph is a trade-mark of A. B. Dick Company. It stands for unequaled stencil-duplicating results, assured by over sixty years of leadership and a nation-wide organization trained to serve users.



DUPLICATOR

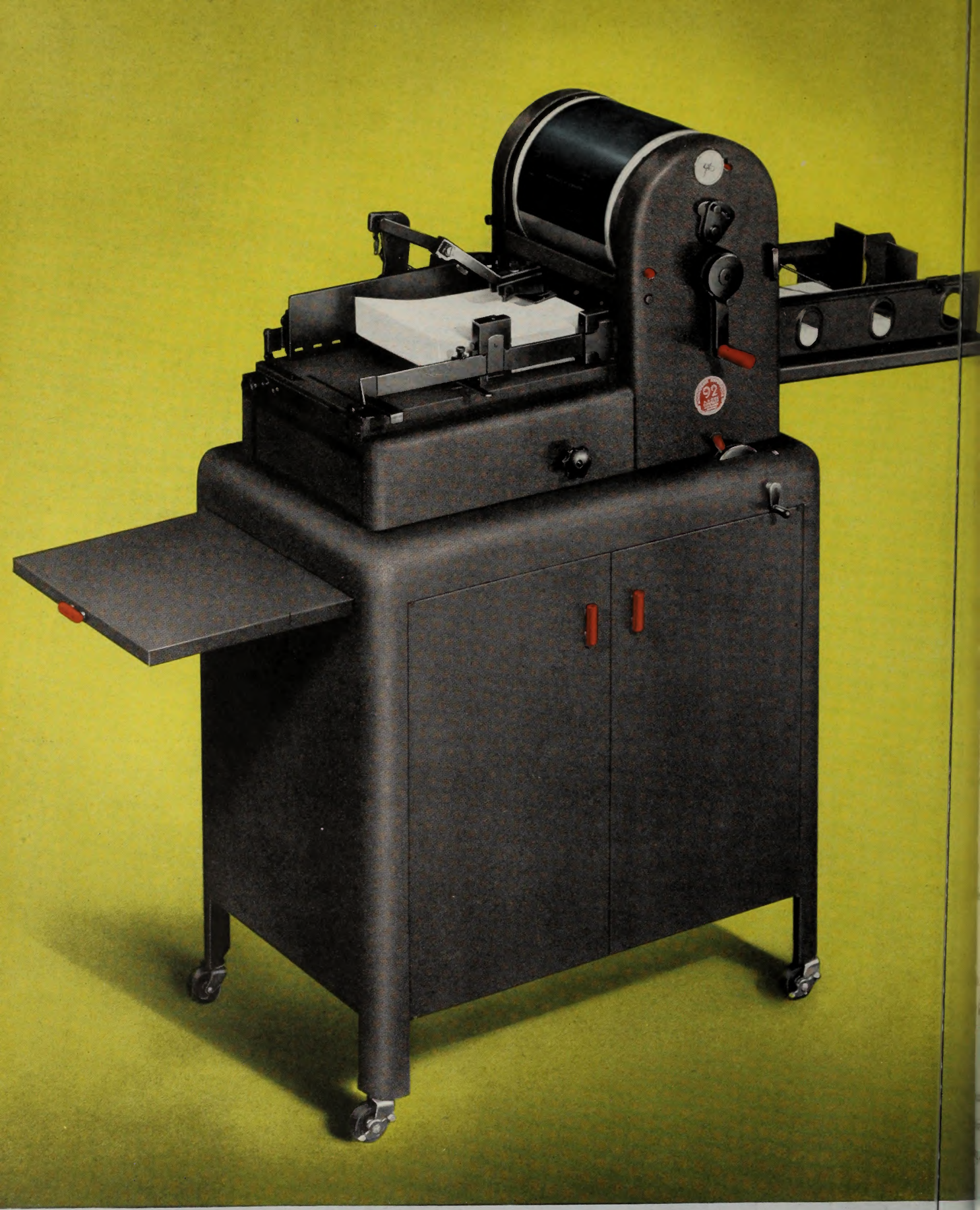
Duplicator, in this instance, means Mimeograph stencil duplicator—the easiest, fastest, most economical means of reproducing a few or a few thousand forms, bulletins, letters, etc., in the privacy of your office.

A·B·DICK COMPANY·CHICAGO 6

Figure 1

Branches and distributors in principal cities

Pyright 1946, A. B. Dick Company



Mimeograph 92 duplicator on Mimeograph 16 stand

Mimeograph

92

duplicator

Heavy-duty, high-speed stencil duplicator

Tens, hundreds, *thousands* of highly legible, low-cost copies easily produced in black or color

Accurate Registration A

No variation from the desired position of the copy on the impression paper—important for filling-in forms and for multiple-color work.

Automatic Ink Distribution B

Closed cylinder contains ink reservoir which holds a supply of ink sufficient for thousands of copies. The turn of a lever redistributes the ink supply.

Ream Feed C

The feed table holds 500 sheets of substance 20 paper at one time.

Automatic Paper Feed D

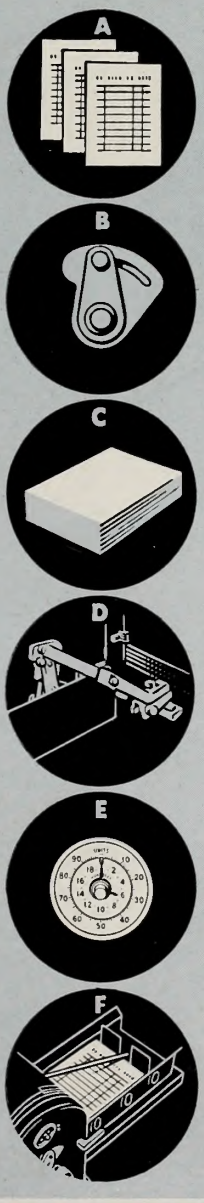
Single sheets move into position at each turn of the cylinder at the rate of 50 to 150 sheets per minute.

Recorder E

Counts duplicated copies and automatically stops paper feed when set amount has been duplicated.

Copies Neatly Stacked F

Duplicated copies are delivered horizontally to back of receiving tray. Tray can be tilted for improved stacking and reduced offset at various speeds.



Flexible Positioning of Copy

The position of the copy on the impression paper may be changed up or down or sideways by simple adjustment of scale-marked controls.

Many Sizes and Weights of Paper

from substance 16 to card stock, in sizes ranging from 3x5 inches to 8½x16 inches.

Color Inks

A pleasing variety of color inks is available. Several colors may be duplicated at one time.

Simple Operation

All of the main operating controls are accented in red and are designed to respond instantly to the touch of the operator.

Added Features

The impression roller is ink and oil resistant. It rises only when paper is in position to receive an impression . . . This prevents roller offset, saves paper, time and cleaning . . . Safety crank and brake . . . Central oiling system for certain main bearings . . . The cylinder is easily removable.

Mimeograph is a trade-mark of A. B. Dick Company registered in the U. S. Patent Office

See electric-drive equipment on back page ➡

This Interlayer is a device which holds a book of one hundred cardboard slip-sheets so that one page at a time is flipped down over each copy as it comes out of the machine. When the book, or Intertray,[1] is filled, it is removed from the Interlayer and stood up on its binding end with the printed copies between each of its pages. In this way, the air is allowed to circulate through them more easily than if they were stacked, and they dry within a matter of minutes.

It should be said in passing that the machine will automatically handle any weight of paper, from a light sixteen pound stock up to the heaviest of cardboards. The Company did have one dissatisfied customer out West once, who complained that the machine would not do what he had expected of it at the time he bought it, and that was, that it would not take red-wood shingles.

3. Special Feed Tables

There are in many cases, however, certain peculiarities in the sizes of the impression paper or in the stock itself, which make special feeding attachments necessary. If, for instance, every other sheet has a carbon back, or the size which it is desired to run is less than three and one-half inches wide, then special feeds

1. Intertray is a trade mark of the A.B.Dick Company

are necessary.

Or if the job requires half a dozen different sized cards on each run, then special guides for hand feeding must be devised. Some of these devices can be clipped over the standard feed table, so that the machine can be converted to the regular or the special uses. In other cases, the special feed tables must be built into the machine, so that it can be used for only that one application.

4. Stencil Transfer Device

Another special device is the Stencil-Transfer and Universal Clamp.[1] This is used when attaching stubless stencils to the cylinder. These stencils, which will be described more adequately in the next chapter, have no button holes as the standard stencils do, and so in order to make sure that they go on to the cylinder straight and accurately, this Transfer device is used. It is attached to the back of the machine. A stubless stencil is placed in position on it. The cylinder is turned until it hits a set stop, and when the transfer device is slid into position against the Universal Clamp, the stencil is automatically placed in the proper position for laying it down over the cylinder.

Besides all of these special devices which

1. See Appendix A for illustration of the Transfer Device.

are necessary.

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Besides all of these special devices which

1. See Appendix A for illustration of the Transfer Device.

are attached to the machine, there is one which is used separately. That is the Mimeoscope.[1] It is an illuminated drawing board on which stencil sheets can be fastened, and with the use of various styli, forms can be drawn or pictures traced. Lettering guides can also be used on the stencils for heading up the forms or putting captions on the pictures.[2]

5. The Inks

The paper stock used in production control applications is, to a large extent, hard faced or glazed, and generally unsuitable for use with oil-base mimeograph inks which dry by penetration into the paper. In order to correct this condition, a new Hard-Set ink,[3] which dries by oxidation, has been developed. It gives a jet black permanent copy which will dry hard on any kind of cloth or paper stock in eight minutes or less. Furthermore, the copy will not wash off in any kind of oil bath, or saline solution, or acid immersion through which it may be passed provided the ticket itself does not disintegrate; nor will

1. Mimeoscope is a trade mark of the A.B.Dick Company. See Appendix A for an illustration of the Mimeoscope.

2. See Appendix B for prices of all equipment.

3. See Appendix B for prices on Hard-Set inks. Hard-Set is a trade mark of the A.B.Dick Company.

it fade in the sun light.

It has other qualities besides toughness, and other advantages too, over the oil base inks. Since they dry by penetration into the paper, they are likely to penetrate practically through to the other side of a thin sheet, and this makes printing on both sides of thin paper a rather illegible job. The hard-set ink, on the other hand, drying by oxidation is a very suitable ink for printing on both sides of light weight paper. This particular advantage makes the printing of Operation Manuals or Job Analysis programs, much less bulky jobs.

It must be stated however, that there are some disadvantages to this ink, too. Since it dries so much faster than the oil base inks, it must be used on jobs big enough to keep it flowing through the pad; otherwise, the pad itself will dry out. The pad should be changed about once a week in order to assure good copies and an even flow of the ink.

6. Filing the Stencil

These same hard-drying qualities complicate filing and re-running problems. Unless the ink is blotted or washed out of the stencil immediately after using it, the ink hardens in the openings of the stencil making any future use of the stencil an impossibility. Depending upon whether the stencil is to be saved so that more copies can

be run off at some future time, or whether additional material is to be typed on the stencil and then more copies run off, two different filing procedures must be followed.

If the stencil is to be saved for future use without making any corrections on it or adding anything to it, a filing wrapper known as a Sorbset[1] wrapper is used (Figure 2). This wrapper is made of a specially prepared blotting paper which will draw all of the ink out of the stencil openings and leave it in a perfectly clean condition for any future use.

This filing wrapper can not be used however, if it is desired to make corrections or add material to the stencil before running it again. The reason is that the Sorbset filing wrapper is so absorbent that it also has a tendency to draw the oils as well as the ink out of the stencil. This will not harm the stencil if no more material is to be added to it, but it does tend to make it brittle, and hence more difficult to type on successfully. So in this case the stencil should be washed before being filed.

7. The Stencil Washing Machine

To keep this from being a messy job, the A.B.Dick Company has developed a stencil cleaning machine.[2]

1. Sorbset is a trade mark of the A.B.Dick Company.

2. See Appendix A for an illustration of the stencil cleaning machine.

MIMEOGRAPH FILING WRAPPERS

SAVE STENCILS

SAVE TIME

SAVE EXPENSE

Mimeograph filing wrappers are used to preserve stencils for future re-runs. Mimeograph Oilsorb and Sorbset wrappers do not require pre-cleaning of the stencil before filing. (Use OILSORB wrappers with oil base and emulsion inks, and SORBSET wrappers with hard-set inks.)

INSTRUCTIONS FOR USING OILSORB AND SORBSET WRAPPERS:

1. Remove stencil from cylinder as soon as run is completed.
2. Place stencil, INKED SIDE UP, in an open, clean filing wrapper.
3. Close wrapper and rub entire top surface with a smooth hard object such as the bottom of an ink bottle. Make sure a good all-over contact between wrapper and stencil is obtained. The wrapper will absorb the ink, thus cleaning the stencil.
4. File with folded side of wrapper up.

OILSORB FILING WRAPPERS . . . for use with inks Nos. 1767X, 1757X, 1590, 767, 7290, 1591, 1767, 7280

No.	Use with Mimeotype or Cellotype stencil sheets	Size of wrapper folded, inches
973	Legal size or smaller	9x19
934	Stubless legal size, letter size or smaller	9x15
935	Stubless letter size, regular note, stubless note or smaller	9x12
936	1090K or smaller	6x9
937	1089K	4½x9
938	993, 1093K, 979, 1079K	13x23

SORBSET FILING WRAPPERS . . . for use with inks Nos. 1762 and 1764

No.	Use with Mimeotype	of wrapper
	stencil sheets	d, inches

Figure 2

PRODUCTION AND MACHINE TOOL ROUTING

SPRING SEAT & LOWER — WRITTEN BY SKELLY — PART NO 5226005
Steel — DATE EFFECTIVE 6-30-45
1 A — B/P CHG. DATED
SHEET 1 OF 1

OPERATION NAME	MACHINE NAME	MACH. NO.	TOOLS - GAGES - JIGS - FIXTURES	TOOL NO.	REG. NO.	STANDARD TIME MINUTES	STANDARD TIME HOURS	STD. PROD.
TURRET #4			15/16" #3 MT Bottom Drill	26520				
			M-949 #3 W&S Socket	22R92				
R.Ream								
TURRET #5			31/32" #3 MT Bottom Drill	25321				
			M-949-3 W&S Socket	22R92				
Finish Ream & Bottom								
TURRET #6			W&S Face Tool Holder M-1932	32R238				
Face			Face Tool	11400				
REAR CROSS SLIDE			Luers #4 Holder					
			Luers #4 C. Off Blade					
Cut off								
Truck to M2-P								
TUMBLE to remove burrs					Est.	.06	.0010	
Truck to M2-C								

DATE 7-18-45

This machine has a metal drum on which the stencil is placed when it is removed from the Mimeograph duplicator. When the operating handle is pushed over, the drum begins one slow revolution while a stream of water is played on the stencil under the hood of the machine.[1] Upon the completion of one revolution, a matter of a few seconds, the stencil is completely clean and can be filed in an oiled wrapper.

The question is often asked, "How many copies can you get from a pound of ink?" This, of course, is very difficult to answer since the number of copies depends entirely upon the amount of material typed on the stencil. A rough average though is between five and ten thousand copies per pound.

1. See Appendix B for the price of this machine.

Chapter III

Standard Stencil Sheets

1. Definitions

Before going into the various types and sizes of stencils which have been developed in the last several years for production control applications, it might be well to begin with a definition of stencils. There is a distinction to be drawn between stencils and stencil sheets. A stencil sheet is a sheet of paper- fibre coated on both sides with the blue or the yellow cellulose material which gives it it's final form. This stencil sheet becomes a stencil after it has been cut in a typewriter or with a stylus on a Mimeoscope.

In the typing operation, a cushion sheet is first placed between the stencil sheet and the backing sheet. The whole assembly is then inserted in the typewriter. The ribbon is disengaged, so that when the keys are struck, the type faces will strike the stencil sheet itself and form the letters by pushing the cellulose material aside at that point and leaving the fibre sheet exposed.

When the stencil is then put on the Mimeograph duplicator, the ink is squeezed through these openings onto the impression paper. So much for an explanation of the basic duplicating process itself.

These stencil sheets come in various types and sizes, which will be discussed in this chapter.

2. Mimeotype Stencil Sheets

The Mimeotype[1] stencil sheet(Figure 3) is a blue one used generally for both typing and drawing work. It is particularly adaptable for drawing because, when a line is drawn on it with a stylus on the Mimeoscope, a white light appears through the blue stencil making it easy to see what is being drawn.

This stencil comes in several standard sizes.

Mimeotype Stencil Sheets

Number	Impression Paper Size
960 Legal size	8½ x 14 inches
961 Letter size	8½ x 11 "
96s Note size	5½ x 8½ "
993 Large size	12 x 18 "

3. Cellotype Stencil Sheets

The Cellotype[2] Stencil Sheet (Figure 4) is a yellow one usually used for typing only. It will give the same quality of work on drawing as the 960, but a difficulty arises in using it on a Mimeoscope. The white light showing through the yellow stencil makes the work a

1. Mimeotype is a trade mark of the A.B.Dick Company.

2. Cellotype is a trade mark of the A.B.Dick Company.

MADE ONLY BY
A. B. DICK COMPANY
CHICAGO

*TRADE-MARK REGISTERED
IN U.S. PATENT OFFICE

980
MIMEOGRAPH*
STENCIL SHEET
MIMEOTYPE*

JOB NO. _____ DATE _____
NUMBER OF COPIES _____
KIND OF PAPER _____
INTERLAY _____
TIME WANTED _____

MIMEOGRAPH BRAND STENCIL SHEET FOR THE *MIMEOGRAPH* DUPLICATOR

TOP EDGE GUIDE FOR IMPRESSION PAPER FOR MIMEOGRAPH DUPLICATORS 77, 78, 90, 91, 92, 96 AND 100







READ INSTRUCTIONS CAREFULLY BEFORE TYPING

FOR POSTAL CARD STENCIL USE THE RECTANGULAR SPACE ABOVE

Fig 4.

MIMEOGRAPH PRODUCT
MADE ONLY BY
A. B. DICK COMPANY
CHICAGO

1060K MIMEOGRAPH*
STENCIL SHEET
CELIOTYPE*

*TRADE-MARK REGISTERED IN U. S. PATENT OFFICE
MADE IN U.S.A.

TOP EDGE GUIDE FOR IMPRESSION PAPER FOR MIMEOGRAPH DUPLICATORS 77, 78, 90, 91, 92, 96 AND 100

Figure 4

MIMEOGRAPH BRAND STENCIL SHEET FOR THE MIMEOGRAPH DUPLICATOR
FOR POSTAL CARD STENCIL USE THE RECTANGULAR SPACE ABOVE
READ INSTRUCTIONS CAREFULLY BEFORE TYPING



little more difficult to follow.

This stencil sheet is manufactured in the same sizes as the 960 series with the following identifying numbers:

Number	
1060k	Legal size
1061k	Letter size
1096k	Note size
1093k	Large size

In running the two smaller sizes of these stencils, that is the 961, and the 96s, and the 1061k and the 1096k, it is necessary to cover up the exposed part of the ink pad with a piece of paper extending from the bottom of the stencil down to the end of the pad. If this paper is extended up under the bottom end of the stencil about three quarters of an inch, it will prevent any leakage of the ink at that point.

4. Stubless Stencils

The main development of these stencils for production control uses in the factory has been with the 1060k Cellotype stencil sheets. In order that none of the stencil would be wasted when small cards or tickets were run, two very much smaller stencil sheets were introduced. They are the 1090k and the 1089k. The 1090k is $5\frac{1}{4}$ x $8\frac{1}{2}$ inches and the 1089k is 4 x $8\frac{1}{2}$ inches. (Figure 5)

1089K MIMEOGRAPH* STENCIL SHEET CELLOTYPE*

DE IN U.S.A. MIMEOGRAPH PRODUCT MADE ONLY BY A. B. DICK COMPANY, CHICAGO *Reg. U.S. Pat. Off.

1090K MIMEOGRAPH* STENCIL SHEET CELLOTYPE*

Figure 5

1090K MIMEOGRAPH STENCIL SHEET CELLOTYPE*

These small stencil sheets are used in several different ways. They may be used as a variable strip at the bottom of a letter or note size stencil. In this case, the letter size stencil will have some information which remains the same every time the job is run. This is known as the constant information, and this stencil may be used over and over again. Each time it is run, however, certain variable information must be printed with it.

Every time the job is run then, this variable information is typed on a 1090k stencil. The letter sized stencil is laid on the cylinder in its normal position, and the 1090k is laid at the bottom of it with about half an inch of the letter size stencil overlapping the 1090k. Then when the impression paper is run through the machine, it will pick up a copy of both the constant and the variable information.

When these small stencils are used by themselves, to print small cards or tickets, it is necessary to mask out most of the ink pad with a protective cover. A window cut in the top portion of a protective cover just large enough to allow only the printed matter on the stencil to come into contact with the pad does this job very nicely. The stencil is then placed over the window and one end of it clamped under the stub clamp at the top of the cylinder.

It should be mentioned that the stub clamp on all of the 90 series duplicators is so constructed that button holes on the stencil stubs are not necessary. Any piece of stencil when placed under this clamp will be held securely in position. That is why it is possible to use these small pieces of stencil. In fact they are often cut into two or three or four pieces when the cards being duplicated are small enough to warrant it. This, of course, cuts the cost of these inexpensive stencils down just so much further.[1]

Another development in these stencil sheets was brought on by certain filing problems. The standard 1060k, 1061k, and 1096k stencils all have stubs at the tops which make it difficult to file them in standard sized legal, letter or note sized files. They must be folded in order to fit in at all, and this of course, cuts the available filing space at least in half, to say nothing of the inconvenience and general disorder which are also caused. By eliminating the stencil stub, which is unnecessary on the new machines any way, and cutting one and a half inches off the bottom of the stencils, this problem is solved.

Since this stencil will only fit on the new models, however, and since there are many thousands of the

1. See Appendix B for prices of 1089k and 1090k stubless stencil sheets.

older models still being used, the older stencils can not be eliminated. The new stubless stencils are known simply as 1060k2 (Figure 6), 1061k2, 1096k2.

5. Double Stencils

During the war, it was found in many instances that it would be a great help if it were possible to type two stencils at once. The development of the 1060k2d (Figure 6) stencil sheet solved this problem. It is an assembly of two stencils on one backing sheet both of which can be very clearly typed in one operation. In using it, one department may type on it, tear off the top stencil, run it, and forward the second stencil with the backing sheet still intact to another department where more information can be added before it is run.[1]

6. Continuous Stencils

Still another development has been with a continuous stencil (Figure 7) to be used in International Business Machines Tabulating equipment. This is a legal size stencil which comes in twenty quire rolls with the stencils connected and scored along the long side. It is used to very good advantage in the following way. If the user of the I.B.M. equipment should want more copies than he can get with carbon paper copies, and a single running

1. See Appendix B for prices of 1060k2d and 1061k2d stencil sheets

JOHNS-MANVILLE CORPORATION
STANDARD MANUFACTURING DIVISION
EVERYWHERE, U. S. A.

CONTRACT NO.

REQUISITION NO.

SALES ORDER NO.

RMS No. 5001

DATE



1860

1860

of the tabulating cards through the machine, this stencil is his best means of doing the job. In other words, if he requires more than four or five copies of the information, it will be less expensive for him to cut a stencil and run the desired number of copies off on a Mimeograph duplicator than it will be to run the cards back through the machine a second time.[1]

1. See Appendix A for illustration of this equipment. See Appendix B for prices thereof.

Chapter IV

Single Writing Systems

The primary paper work aim in any system of production control is the reduction of successive writings of the same information to as small a number of writings as possible, and preferably to a single writing. This, of course, is not always possible due to certain vestigial parts of previous systems, which in the process of their change, must carry these now awkward, but nevertheless, vital parts, with them. Basic information in regard to every order that has ever been received in a plant during all of its long history, for instance, may be so arranged on such a small or large card that there is no way of fitting it into a new improved system.

And so with things such as this, extra writings of identical material are often necessary. But, in general, production control systems can be reduced to a very few writings. In the next two chapters, various ways in which this can be done advantageously with a Mimeograph duplicator, will be shown.

The preparation of manufacturing orders is largely a matter of placing both standard and variable information together on a series of forms for the information and guidance of shop executives and workmen. The forms used for this purpose vary considerably from one plant to

another, but the fundamental information to be conveyed to and from the shop is about the same for each industry.

A common tendency in some plants is to prepare another form at the first opportunity. The forms themselves may cost very little more than the paper they are printed on, but the cost of filling them out and later, the cost of analyzing the data they contain, can become unnecessarily expensive, particularly if the data is of little or no value. This tendency to increase the number of forms is recognized by most experienced executives, and they purposely make it difficult to set up new ones. Each proposed new form should be studied and compared with all similar existing forms to see if the proposed form is an actual improvement. If it can be shown that it will effect a substantial saving in the collection or analysis of certain data, or if it will convey certain information with less chances of mistakes, then, it may be justified.

1.Superfluous Forms

In any event, existing forms should be reviewed from time to time to ascertain their usefulness. In a great many businesses, as many as three hundred different forms may be used for various records at one time, when the number of employees may be only two hundred and fifty. In cases like this, a thorough study is necessary to see if various different forms can not be consolidated. It is not unusual in these cases to develop one form which will do in

the future, what five different forms have been doing in the past. Nor is it unusual to find forms on which perfectly useless data is being recorded day in and day out, and then never analyzed for what it is worth, or what is even worse, analyzed at length and then stuck away in some file to be forgotten.

The first test of a form's value is its continued use after its novelty has worn off. A more thorough test is to check from time to time to evaluate the importance of the data which is collected or the information it conveys. The importance of this data can be measured by the significant results which hinge upon its use. Excellent data can be collected, analyzed, and filed, but if nothing depends on it or if no consistent purpose is served, the expense is not warranted.

2. Production Control Forms

The preparation of the manufacturing order to disseminate the information prepared by the production control department requires certain forms to do the best job. To a large degree, these forms comprise the system which is used in the plant. They can provide a more or less automatic way to convey and collect information to all departments contributing to the manufacture and control of the product.

The variations in the arrangement and content of industrial forms are due to the personal opinions and

experiences of the manufacturing executives, to the product itself, and to the methods used to manufacture it. The same functions are more or less general to all manufacturing plants, but the coordinating systems for these functions vary considerably. In one plant a particular function may require a large number of records and supporting data. Another plant making similar products, but having different policies, for example in sales, will require practically no records for the same functions. The first company, may make several hundred different models, whereas the second one may specialize in ten or twenty.

Similar differences may occur within the plants of any one industry and certainly do occur between different industries. There are times when a function may require no records because some executive has grown up with the plant and carries all the information in his head. Generally, the smaller the plant, the easier it is for certain individuals to be trusted to remember the proper thing to do at the right time.

As the plants grow larger, the separate functions become large enough to have specialists deal with them, and it becomes more necessary to depend on the written data and records. The most common method of recording information in modern industries is to use a printed form of some kind. The form literally asks questions and provides spaces

for the answers.

3. Planning Aims

The goal in planning for production, is to prepare the way, and facilitate the carrying out of programs of manufacturing on an efficient, properly timed, well-co-ordinated, and low-cost basis, so as to complete the required amount of satisfactory finished product on a scheduled delivery date. Planning, however, is futile unless the means are set up to apply the plans and do the work in the manner and time decided upon. Checks and controls of a suitable kind are necessary for this purpose, but adequate facilities must also be provided or else the program cannot be carried through as conceived and laid out. It is important, therfore, to set up an effective system of production control, adapted to the nature of work, method of manufacturing, and size of plant, so that regular channels of work and standard procedures may be available to prevent interruptions, clear up delays, and keep production moving.

Production control systems, organized and operated with proper provisions for carrying on the fundamental functions and activities of production planning and control, will accomplish such purposes at the least cost and with maximum results. Such systems must be carefully thought out before an attempt is made to set them up. A mere assembling of separate devices and routines used in different plants, even those in the same kind of industry,

will not necessarily build up a good control system. The "what, why, where, when and how" of the various steps and methods require determination. Forms are important parts of the system, but should not be too numerous, too detailed, not too complicated. Whenever possible, one mechanism or one form should be used for several purposes. Wherever procedures and paper work can be omitted, short-cut, or streamlined and still bring about the desired results, such simplification is to be recommended. Systems need not degenerate into useless work and red tape.

It is obvious that the greater the number of elements involved, the more difficult is the problem of systematizing and controlling them. The value and importance of a production control system increases in proportion to the number of elements to be checked and coordinated.

It is the forms used in this work and their preparation which make up the cutting edge of the Mimeograph duplicator as a tool of production control; and it is this central aspect of the whole problem which is to be explained in the following chapters.

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Chapter V

Die-Impressed Stencils[1]

Many forms, such as "Tool Inspection Records", "Daily Report of Goods Shipped" or "Accident Reports" for instance, are simply printed forms on which certain information is penciled daily. They can be produced economically on the Mimeoscope and then run off on the Mimeograph duplicator; and often when they are required in large enough quantities to make printing a better way of producing them, they are first made up experimentally on the Mimeoscope and the Mimeograph and used and revised until their defects have been worked out. Then they are printed.

With other forms, however, such as "Bills of Material", "Operation Sheets", or "Engineering Change Notices", etc., it is necessary to duplicate certain information on the forms. When using the Mimeograph duplicator for this job, there are two fundamentally different ways of approaching it. The first way is with "Die-Impressed" stencils.[2]

These are stencils furnished with a ruled form or heading already stencilized into them. The necessary typed or handwritten information is added and from

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1. Die-Impressed is a trade mark of the A.B.Dick Company.
2. See Chapter III for sample stencil.

this master, both the form and added text are produced on blank paper stock in one duplicating operation. In this way, the variable fill-in copy is added to the constant forms. They save time and labor for individual daily or weekly reports or notices. They expedite production and simplify controls when used to produce papers needed for paper work systems or procedures.

As has been mentioned before, the ninety series Mimeograph duplicators will give far more accurate registration than the earlier models. And yet, even with the earlier models such as the 77B85, 78B, and 96 of which there are a great many still in use, perfect registration on these variable fill-in jobs can be had by using Die-Impressed stencils.

The actual Die-Impressing is done in one of the A.B.Dick Company's factories in Chicago. All of the various types and sizes of stencil sheets already mentioned with the exception of the continuous stencils, can be Die-Impressed. The job is done on presses with finely cut printing plates without applying any ink to the plates.

1. Cost Factors

In figuring costs on any of these jobs, there are three factors involved:

1. The cost of the stencil sheets
2. Type composition for special dies. (Applies only to the first order.)

3. Die-Impressing charge - based on quantity ordered.

The stencil sheet prices are those which are set forth in Appendix B. The composition charge is determined by the number of inches of ruling on the form and the number of words, based on the following composition scale.

Composition Scale [1]

No. of words or inches of rule	Word rate	Rule rate
1-5	$0.50	$0.30
6-10	1.00	0.60
11-15	1.50	0.90
16-20	2.00	1.20
21-25	2.50	1.50
26-30	3.00	1.80
31-35	3.50	2.10
36-40	4.00	2.40
41-45	4.50	2.70
46-50	5.00	3.00
51-55	5.50	3.30
56-60	6.00	3.60

1. These prices are taken from a published schedule of prices obtainable from the A. B.Dick Company

No. of words or inches of rule	Word rate	Rule rate
61-65	$6.50	$3.90
66-70	7.00	4.20
71-75	7.50	4.50
76-80	8.00	4.80
81-85	8.50	5.10
86-90	9.00	5.40
91-95	9.50	5.70
96-100	10.00	6.00
100	10.00	6.00
200	20.00	12.00
300	30.00	18.00
400	40.00	24.00
500	50.00	30.00
600	60.00	36.00
700	70.00	42.00
800	80.00	48.00
900	90.00	54.00
1000	100.00	60.00

In using the scale, count the number of words and measure the total lineal inches of rule; then refer to the scale to determine the total charge for each. There is an established minimum composition charge of two dollars which applies only when the total charge, as deter-

mined by the scale, is less than two dollars.

A word consists of any given number of uninterrupted alphabetical or numerical characters (may be mixed). Example: "23456", "96-11", "77B85", "$100.00". Initials, abbreviations, or hyphenated words are considered as individual words.

As an example, let us say a form contains 118 words and 120 lineal inches of rule material. To determine the charge for typesetting of the words, refer to the "100" bracket, then to the "16-20" bracket, which designate a $10.00 and a $2.00 charge for the typesetting of words, thus totaling $12.00 for typesetting 118 words. To determine the rule charge for 120 lineal inches, refer to the "100" bracket, which designates a $6.00 charge; then refer to the "16-20" bracket for the remaining 20 inches for which the charge is $1.20, thus totaling a rule charge of $7.20. Add the totals of the charges for ruling and words to obtain the total composition charge of $19.20.

The Die-Impressing charge for all the standard sized stencil sheets[1] is as follows:

Die-Impressing of first quire	$4.00
each additional quire, 2 to 9 quires inclusive	.75
" " " 10 to 19 " "	.65

1. 960, 961, 96s, 1060k, 1061k, 1096k, 1060k2, 1061k2, 1096k2, 1060k2d, 1061k2d, 1096k2d.

each additional quire, 20 to 49 quires inclusive $ .50

" " " 50 quires and over .30

For stencil sheets numbers 993 and 1093k, the Die-Impressing charge for the first quire is $6.00. For the 1089k, 1090k, 1089kd, 1090kd stencil sheets, the charges are:

Die-Impressing-first package		$10.00	(1,000 sheets)	
" "	2 packages	9.80	(per package)	
" "	3 "	6.70	" "	
" "	4 "	6.15	" "	
" "	5 "	5.60	" "	
" "	6 to 9 "	5.00	" "	
" "	10 packages or over	4.75	" "	

2. Economic Feasibility

In considering the economic feasibility of using these die-impressed stencils for any particular job, the cost figures mentioned above should be considered in the following light. If the job is to be done on the Mimeograph duplicator at all, stencils will be used and so, that particular cost figure should not affect any decision as to whether die-impressing is economical or not.

The second of the three figures to be taken into consideration is the type composition charge, but since this charge is made only once and can be amortized over the life of the job, it will eventually amount to nothing. (There is no charge for subsequent plates after the first

one wears out.) So actually, the only figure of real importance in one of these jobs is the die-impressing charge itself.

To show how much this will add to the cost of each individual stencil, the following schedule will break the die-impressing charges down to a per stencil basis.

Number of Quires	Die-Impressing Charge per Stencil
First quire	$.16+
2 to 9 quires	.03+
10 to 19 quires	.02
20 to 49 quires	.02
50 quires and over	.01

It is easy to see from this that after the first quire, the cost of die-impressing stencils is a very negligible one. Suppose for instance, one were buying twenty five quires at a time. The added cost per stencil would be just a trifle over two cents. Consider how many copies would have to be run off then, to get this two cents back in the form of printed forms. How many of these forms could be printed up at that price? Certainly not the twenty or the hundred or the thousands of copies which can be produced on the Mimeograph duplicator from this one stencil.

And yet, this is only one aspect of the question. With Die-Impressed stencils, there is perfect regis-

tration of form and fill-in material on every copy (since they are both produced at the same time). The user is also relieved of the necessity of stocking up great quantities of printed forms which otherwise must be purchased in order to get a good price on having these forms printed. Money is not tied up in these quantities of printed forms, which, if a change is made in the form, must all be thrown away or used as scratch pads. On the other hand, stencils will dry out if kept for too long a time, and they should not be ordered in quantities which will last longer than six months.

3. Die-Cut Consecutive Numbers

It is also possible to have consecutive numbers die-impressed into stencils[1] in any position on the stencil. This would ordinarily be done in conjunction with a die-impressed form and the charge would be twice the normal one. If the copy contains illustrations, trade-marks, insignia, etc., it must be submitted to the general offices of the Company for special estimate. The type faces to be used for all wording may be chosen from several dozen different styles in a catalogue.

4. Die-Cut Windows

A further development of Die-Impressed sten-

1. See Chapter III for sample stencil.

cils is Die-Cut Windows. These will be discussed fully further on in connection with "variable strips", but they should be mentioned here. They are windows which can be cut into a stencil, usually at the top, so that a small piece of stencil containing some variable information can be laid over them. If they are small enough so as not to weaken the stencil after they are cut out, the window is cut completely through the stencil sheet. If on the other hand, they would weaken the stencil by reason of their size, the stencil coating is merely screened off leaving the base tissue intact. Then, when the variable stencil is laid over this window, the ink flows through the base tissue in both the window and the stencil onto the paper. The cost for this work is the same as that for die-impressing consecutive numbers.

It may be stated here that the reason for going into the cost aspect of these die-impressed stencils so extensively is that it is the very essence of all the advantages of the Mimeograph process over the other processes in the field. Although the primary purpose in writing this thesis is simply to present the Mimeograph process to industrial engineers as an efficient tool of production control and not to compare it with other processes; still those comparisons will be made when it is read, and so the vital cost figures must be adequately presented here where the comparisons will be made.

Chapter VI

Form-Topped Stencils [1]

In most cases Die-impressed stencils seem to be the best solution to the problem involved. The second way of approaching the problem of mimeographing information on a ruled form is by means of a Form-Topped stencil sheet. In applications such as purchase order systems or shoe tags, for instance, it is desirable to have the form itself printed. A purchase order which is mailed out to other firms looks a little better when it is printed. And a shoe tag may be so crowded for space that the duplicated information might stand out more if the form itself is printed in red. There are many reasons why it might be desirable to mimeograph whatever information is wanted on a printed form. So in order to simplify the registration, Form-Topped stencil sheets (Figure 8) can be used. These are stencil sheets prepared with a facsimile of the customer's printed form in contrasting color on each stencil sheet surface to guide typists in positioning fill-in copy accurately. That is to say the Form-Topping is done in a silver ink on the blue 960 series stencil sheets and in a bright orange or blue ink on the yellow 1060k series sheets.

The Form-Topped stencil then, with copy

1. Form-Topped is a trade mark of the A.B.Dick Company.

MIMEOGRAPH BRAND STENCIL SHEET FOR THE MIMEOGRAPH DUPLICATOR

*TRADE-MARK REGISTERED IN U.S. PATENT OFFICE

CELLOTYPE*K

TIME WANTED

SEATTLE-TACOMA SHIPBUILDING

ERECTION SECTION

JOB

ITEM

ML LINE	MARK	DESCRIPTION	LOCA
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			

READ DIRECTIONS CAREFULLY BEFORE TYPING

PATENT No. 1526982

ERIAL LIST NO.

ML LINE		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		

typed in position, is used on the Mimeograph duplicator to reproduce the fill-in information on preprinted forms. As stated before, these stencils are used when duplicated copy is to be added to preprinted forms. If identical copy must be added to several different preprinted forms, the forms should be so designed that the fill-in copy will be located in the same position on each printed form.

Form-Topped stencils are used for complete procedures in the same way the die-impressed stencils are used. The main advantage of Form-Topped stencils is that as many copies as you need can be produced from one typing, and several different printed forms may be filled in from only one typing. This reduces production time sharply and eliminates retyping errors. Unless it is necessary to use printed forms, die-impressing is usually preferred to Form-Topping because it eliminates the cost of printing and storing large quantities of forms.

1. Cost Factors

There are only two cost factors involved in Form-Topped stencils. The first is the cost of the stencil sheets themselves. The second is a fixed preparatory charge for the printing plate regardless of the quantity ordered. On all standard sized stencil sheets, this charge is sixteen dollars for the initial order and nine dollars for repeat orders. For the larger stencils, 993 and 1093k, the initial charge is twenty seven dollars and seventeen dollars for

repeat orders. Breaking these costs down to single stencil sheet figures in the same comparative categories as for Die-impressed stencils, will give a clearer picture of relative costs.

Number of Quires	Form-Topping charge per stencil	
	Initial Order	Repeat Orders
1	$.66	$.37
2	.33	.10
9	.07	.04
10	.06	.03
19	.03	.02
20	.03	.01
49	.01	.007
50	.01	.007

This, of course, costs even less than die-impressing. But it does not eliminate the cost of the printed forms to be run through the Mimeograph duplicator. It does, however, give a very accurate guide for typing the stencils, and does assure the required accuracy of registration when these stencils are run off on any of the ninety series machines.

Copy to be form-topped on a stencil sheet should be pen-drawn or printed in black ink on white paper suitable for photographic purposes. If colored ink or colored paper is submitted, it is possible that a color treat-

ment will cause it to reproduce satisfactorily. Usually color treatment charges are about three dollars. Alterations of the form or position of form on repeat orders will require a new plate, for which the initial preparatory charge will apply.

2. Combinations of Form-Topping and Die-Impressing

Certain combinations of die-impressing and form-topping are used too. Consecutive numbering can be die-impressed into a form-topped stencil for use, for instance, in a purchase order system. Or a die-impressed stencil may have some form-topping on it. An engineering change notice may be die-impressed with a form-topped space for sketches at the bottom of it.

In some cases, the form-topping is even done by the customer himself. If he has a special job to do which will not be repeated again in the future and for which there will not be enough stencils needed to make it worthwhile having them form-topped at the A.B.Dick Company factory in Chicago; or if he needs some form-topped stencils in a hurry, he can do the job on his own Mimeograph duplicator in this way. He draws the form he wants on a stencil and then runs more stencils (They must be the yellow stencils so that the black ink will show up on them) through the Mimeograph, duplicating the form on them. The hard-set ink will dry on these stencils within a matter of several minutes and they will be ready to insert in the typewriter

for typing.

3. Block-Outs

It can now be readily seen how these various types of stencils can reduce the necessary recopying of a great deal of material or information in many production control systems. When all of the pertinent information is reduced to a single writing however, the master stencil may contain some information which should not appear on certain copies. This makes it necessary to block this material out on the copies where it is not wanted. These block outs can be performed in several ways.

In most cases where blocking out is necessary, the form is designed so that the material to be blocked out is located at the top of the stencil. Then, when the desired numbers of copies have been run with this information on them, a piece of paper is slipped under the stencil clamp so that it covers that part of the copy to be blocked out. The remaining copies are then run off with this information deleted.

If the form can not be designed or redesigned so as to bring the block out at the top of the stencil, it is possible to make a block out in any position at all on the stencil. This is done with onion skin or any other very thin second sheet typewriting paper. Cut to the proper size, this paper will adhere to the ink on the stencil for

fifty copies or so without slipping. In this sort of work, that is usually plenty of copies. But if more copies are needed a stencil can very often be turned sideways or even bottom end up and run that way so that the block out can be placed at the top of the cylinder where it can be clamped in place for as many copies as necessary.

Another block out problem is presented when the customer wants to block certain information out of one or two copies in the middle of a run and then let it show up again. The difficulty here, lies in the fact that a block out made with ordinary paper or the onion skin mentioned above, will so smudge the copy on the stencil, that a dozen or more wasted copies will have to be run after the block out is taken off before the copy will be clear again.

This situation is corrected by using either a sorb-set or an oil-sorb[1] filing wrapper cut to the proper size. This paper will blot the copy it comes into contact with instead of smudging it, and when the block out is removed from the stencil, it will leave the stencil clean so that the very next copy through the machine will be a perfectly legible one.

1. Oil-sorb is a trade mark of the A.B.Dick Company. The sorb-set filing wrapper is explained in chapter two in connection with the filing of stencils when hard-set ink is used. The oil-sorb wrapper is a similar filing wrapper for use with oil base inks.

In some cases, the copy to be blocked out is so close to the copy to be printed, that the thickness of the sorb-set file wrapper block out will keep part of the desired copy from showing. In these cases, the oil-sorb wrapper, which is thinner, will do the job even though hard-set ink is being used.

4. Variable Strips

There are many cases where a block out is not feasible. In these cases, the problem is not to delete information from the master stencil, but rather to add certain variable data each time the job is run. On a production order, for instance, the manufacturing information will be the same every time a new lot of a certain item goes into production, but the amounts to be made, and the date, and the order number, etc., will all be different on every order. In these cases a variable strip will be run along with the constant master stencil on each job.

This variable strip can be handled in various ways. Usually it is put on a 1089k or 1090k stencil and laid on the cylinder under the bottom edge of the stencil with the constant information. Often, even these small stencils can be cut into two or three or four pieces depending on the amount of information typed on them and run that way, thus cutting stencil costs down even farther. If the variable information must appear at the top of the form, then special stencils can be used which have Die-cut windows

in them. These windows cut at the top of the stencil, make it possible to clamp both the constant information stencil and the variable strip at the top of the cylinder. The variable strip is laid over the window which has been cut out.

In its present state of development, the Mimeograph duplicator as a tool of production control, is made up of all the things which have been mentioned so far in these first six chapters; the machines, the stencils (both die-impressed and form-topped) and the inks. In the ensuing chapters specific cases showing just how all of these phases of the process are being used in production control in various plants all over the United States will be presented and discussed.

Chapter VII

Bills of Material and Process Sheets

1. The Foster Engineering Company

The Foster Engineering Company of Newark, New Jersey, manufacturers of automatic valves, produce their Bill of Material (Figure 9) by means of a Mimeograph die-impressed stencil and the Mimeograph duplicator. The job is done on a 1061k2 stubless stencil, so that when the job is finished, the stencil can be filed in a standard letter size file for future use. Nine preprinted forms and nine sheets of plain card stock receive a single impression. Distribution of these eighteen copies covers ten departments. The possibility of error is largely eliminated by the single writing of the basic data which this method affords.

When the Sales Order and the customer's specifications are received in the Engineering Department, that department prepares all of the necessary drawings and a pencil copy of the Bill of Material. The data is then typed on a mimeograph stencil into which the Bill of Material form has been die-impressed. Eighteen copies are duplicated from this stencil which is then filed for use when repeat orders for the same product are received.

Nine of the eighteen copies are permanent file copies and are duplicated on plain card stock (11" x 14" folded to 8½" x 11" , so as to conform with the size of the

SIZE	TYPE	SERIES	DESCRIPTION	MATERIAL	DATE	S.D.
1-1/4"	38 U	SCR.	PRESSURE REGULATOR	BRONZE	1-21-42	
QUAN.				TRIM	ASSEM.	B.M.
				BRONZE	PAGE 1 OF 1 PAGES	4025

FOSTER ENGINEERING COMPANY NEWARK, N. J.

NO.	NAME	DRAWING	PATTERN—REMARKS	MATERIAL	SPEC.	NO. PER UNIT
1	BODY	D2419	11091	BRONZE		1
2	MAIN VALVE	E2423	11093	BRONZE		1
3	DISC 1-5/8"OD.11/32"TK.3/4"ID.		COMM'L	RUBBER		1
4	BOTTOM PLUG	E2420	11092	BRONZE		1
5	INTERMEDIATE BUSHING	E2422	11094	BRONZE		1
6	BAL.PISTON CUP LEATHER	E3153	1-1/4"OD.3/4"ID.7/32"LIP 1/16"	LEATHER	COMM'L STOCK	1
7	PISTON	E2424	11095	BRONZE		1
8	PISTON CUP LEATHER	E3153	2"OD.1-1/4"ID.1/4"LIP 1/16" STOCK	LEATHER	COMM'L	1
9	PISTON FOLLOWER	E2332	11087	BRONZE		1
10	SPRING 3/4"ID.2-1/2"LG. PL.			STEEL	COMM'L	1
11	SPRING CHAMBER	E2326	11088	BRONZE		1
12	SPRING WASHER	E5854	1-1/4"DIA.1/2"LG. BR. ROD			1
13	ADJUSTING SCREW 3/8"-16x2" SQ.HD.RD.PT.S.S.			STEEL	COMM'L	1
14	CAP (NOT USED)	E7833	1-1/8"HEX 1-13/16" LG.BR.ROD			1
15	MAIN VALVE STEM	E2423	9/16"DIA.4-5/8" LG.P.M.G.			1
16	3/8"-16 HEX FOR #13		PALNUT	DURONZE	COMM'L	1
17	MAIN VALVE PIN	E2423	1/8"DIA.1"LG.	BR. ROD		1

Figure 9

PRODUCTION WORK SHEET

PURCHASE DEPT. COPY

S. O.
R. O.
DATE

TOTAL AMT.	P. O. NO.	VENDOR	REMARKS	DATE WANTED

former Bill of Material). The blank area at the end of each copy is used for pencil notations. The distribution of these nine copies is as follows: one copy to the Assembly and Inspection Department to let them know the job is coming along. One copy to the Shop as advance notice to them. One copy to the Sales Department to let them know that the job has been started. One copy each, to the Production Control, Stores and Purchasing Departments as permanent file copies for their own reference. They will also get other copies, but these will be used and moved around so much, they want the file copies where they can always put their hands on them. The Engineering Department will get two of the file copies, one to be filed by number and the other to be filed by the product name.

Nine more copies of the Bill of Material are duplicated on large sheets of paper folded to 8½"x11". One rather unique aspect of these nine copies is that they are produced from a die-impressed stencil on preprinted forms. Usually, form-topped stencils are used with preprinted forms, but in this case the printed part of the form is placed at one end of the paper. Then, this is folded under and the die-impressed form is Mimeographed on the 8½"x11" blank portion which is left. The registration must of course, be very accurate, in order to make the two parts of the form line up. Of these nine copies, six are white and the other three are green, blue, and yellow, respective-

ly. Four of the white copies have the heading, "Production Work Sheet" printed on them, and are then further identified as the Control Department copy, the Cost Department copy, the Purchase Department copy, and the Stores Department copy. All nine of these copies are sent with the sales order to the Stores Department.

In the Stores Department, the blue copy of the Bill of Material is used as a work sheet to which is added the required quantity of each stock item which is needed to make the product ordered. Each part is also checked and marked to indicate if it is a purchased part, finished part or semi-finished part, a part that must be made, or a part available from stock. Here, too, all parts to be purchased or made are listed on the back of the Sales Order.[1]

The colored copies are filed temporarily in the Stores Department, while the six white copies, with the Sales Order, are sent to the Planning Committee.

The Planning Committee sets the shipping date for the product, then sends the Sales Order and the six copies of the Bill of Material to the Purchasing Department. In the Purchasing Department, the quantities of parts

1. It should be noted here, that even with this system, rewriting of essential information has not been eliminated altogether. A single writing system is always the aim, but it is seldom achieved.

to be purchased or manufactured are added to the four Production Work Sheet copies of the Bill of Material: the Purchase Department copy, the Cost Department copy, the Stores Department copy, and the Control Department copy. Also in this department, work tickets on all purchased parts and on parts to be manufactured are prepared.[1]

Purchase Orders are issued for the parts to be purchased, and the Purchasing Department copy of the Bill of Material is filed for follow-up.

The Control Department copy of the Bill of Material, the two other white copies of it, and the work tickets are sent to Production Control. From that department, the work tickets on all purchased parts are issued to Receiving Inspection, and work tickets on all parts to be manufactured are issued according to the schedule to the Shop. The two white copies of the Bill of Material are used for follow-up.

The Stores Department copy of the Bill of Material is sent to the Stores Department, where it is used to record items as they are received ready for assembly. When all necessary parts have been received and the product is ready for assembly, the yellow, blue, and green copies of the Bill of Material are removed from file. The yellow

1. The actual preparation of work tickets, however, will be discussed in a later chapter.

copy is placed with the parts and sent to Assembly. The green copy is marked to show what items were supplied out of stock at the time the parts went to Assembly, and sent to the Cost Department. The Stores Department makes the proper entries in their inventory records and files the blue copy in a permanent file.

Meanwhile, the Cost Department copy of the Bill of Material has been sent from Purchasing to Cost where it is used to record all costs against the order. The purchase order number, the vendor's name, date, weight of material or castings, outside machining costs, material and labor costs are recorded on this copy. To the total thus secured, are added the cost of stock parts (This is taken from the green copy sent from Stores Department.), cost of assembling the product, shipping charges,etc. This final total is the actual cost of each order shipped.

If a company does most assembly work, the Bill of Material will be the biggest part of their production control work, for it brings all of the parts which are to be made into one product together on one piece of paper before the actual job of assembly begins. If the company's work is more of a manufacturing nature, however, then the Process Sheet or Operation Sheet becomes the basis of Production Control. This form lists all of the operations to be performed on one part of the final product. But whether the form lists the parts to go into the final product or the

operations to go into each part, its function is practically the same. It tells how the job is to be done.

2. The Detroit Diesel Engine Corporation

The Detroit Diesel Engine Division of the General Motors Corporation in Detroit, Michigan, uses a process sheet which is a good basic example. They produce their Production and Machine Tool Routing Form (Figure 10) by means of a Mimeograph 1060k2 die-impressed stencil and the Mimeograph duplicator. The Mimeograph duplicator replaced a competitive process on this job because of (1) greater speed, (2) lower cost of supplies, (3) greater ease in handling, (4) the advantages of hard-set ink, (5) the clarity and uniformity of the copies, (6) easy maintenance of the machine, (7) the elimination of printed forms required by other processes, (8) the high quality of the rerun copies.

3. The Process Sheet

In Detroit Diesel's manufacturing sequence, the process engineering group receives from the product engineering group, detailed drawings and specifications necessary to the manufacture of each part required in a complete assembly. From the initial data, the process engineers start to prepare the Production and Machine Tool Routing Form. The preliminary pencil copy which they originate is called the Process Sheet. The final duplicated copies are called Production and Machine Tool Routing Forms.

DE-348-STEN
REV. 3-23-45

PRODUCTION AND MACHINE TOOL ROUTING

PART NAME SPRING SEAT - LOWER
WRITTEN BY SKELLY
PART NO. 5226005
MATERIAL Steel
DATE EFFECTIVE 6-30-45
MODELS 201 A
B/P CHG. DATED
PCS. PER UNIT
SHEET 1 OF 1

CONT. NO.	OPER. NO.	DEPT. NO.	OPERATION NAME	MACHINE NAME	MACH. NO.	TOOLS - GAGES - JIGS - FIXTURES	TOOL NO.	REG. NO.	STANDARD TIME MINUTES	STANDARD TIME HOURS	STD. PROD.
	10	M2-B	TURRET #4			15/16" #3 MT Bottom Drill	26520				
						M-949 #3 W&S Socket	22R92				
			R.Ream								
			TURRET #5			31/32" #3 MT Bottom Drill	25321				
						M-949-3 W&S Socket	22R92				
			Finish Ream & Bottom								
			TURRET #6			W&S Face Tool Holder					
						M-1932	32R238				
			Face			Face Tool	11400				
			REAR CROSS SLIDE			Luers #4 Holder					
						Luers #4 C. Off Blade					
			Cut off								
			Truck to M2-P								
								Est.	.06	.0010	
	20	M2-P	TUMBLE to remove burrs								
			Truck to M2-C								

TYPED VCS
DATE 7-18-45

Figure 10

After the operations necessary to machine a piece part have been determined, and the sequence of these operations has been decided upon, the pencil copy of the Process Sheet is forwarded to the Record Group in the Mechanical Section. When the Process Sheet is received by the Records Group, Form DE0982, "History of New Parts Released" (Figure 11) is filled out and the date of receipt is noted thereon. If the part has been previously released, the "History" form is withdrawn from the permanent file and the new date of receipt is noted thereon. This form serves as a control record and is also a complete history of a piece part from the time of its inception to its obsolescence. The Process Sheet is then forwarded to the Tool Stores Group. At this point, all tool numbers are checked. If new tools, fixtures, gauges, etc., are needed to machine or perform inspection after machining, new tool numbers are assigned at this time, and orders for new tooling are placed. The Process Sheet is then returned to the Records Group.

The Process Sheet is carefully checked for legibility and understandability. Questionable data is clarified with the Process Engineer before proceeding. When all tooling is available, the Process Sheet is forwarded to the Time Study and Plant Layout Group of the Standards Section. At this point, standard time for each operation is added to the Process Sheet. The Process Sheet is then

JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.

DE-982

HISTORY OF NEW PARTS RELEASED

PART NO.

PART NAME

CONTROL NO.

DATE RECEIVED

MODEL

DATE RELEASED

SCHEDULED TO BEGIN

TOTAL PCS. REQUIRED

PROCESS ENGINEER

REMARKS

PROCUREMENT	
PURCHASED COMPLETE	
PURCHASED IN ASSY.	
PURCHASED SEMI-FIN.	
MADE AT DIESEL	
MACHINED AT DIESEL	
SHOP ASSEMBLY	

DATE RECEIVED	CONTROL NO.	TOOL STORES	TIME STUDY	B/P	HELD UP	PROD. PLAN.	B/P	RELEASED

forwarded to the Cumulative Standards Group, also in the Standards Section.

In the Cumulative Standards Group, they add the standard hours and minutes to the Process Sheet. They also type in triplicate a Cumulative Standard Time Sheet (Figure 12) which shows the total time accumulated by each manufacturing department. This data is taken from the Process Sheet. The original copy of the Cumulative Standard Time Sheet is forwarded to Cost Accounting where it is used to credit Standard times. The duplicate goes to Production Control where it is used for man-loading. The triplicate copy is filed. After completion of these functions, the Process Sheet is returned to the Records Group of the Mechanical Section.

4. Duplicating the Process Sheet

Record of receipt of the Process Sheet from the Standards Section is made on Form DE-982 (Figure 11). The Process Sheet is now complete and ready for transcription. The Process Sheet is given to the typist who will transcribe it to Mimeograph Stencil Form DE-348, "Production and Machine Tool Routing". Proof-reading is done by the typist. The Process Sheet is filed and the stencil is forwarded to the Tool Design Blue Print Crib for duplication. Form DE-348 is die-impressed on a 1060k2 legal sized stubless stencil. This is placed on the Mimeograph 92 duplicator

CUMULATIVE STANDARD TIME SHEET

DE 833
Standards Section M-8
Job Standards Dept.

OPER. NO.	STD. TIME	DEPARTMENTS						BURDEN CENTERS		
								A	B	C

and the required number of copies duplicated.

After the copies are duplicated a number 972 Sorb-set filing wrapper is passed through the Mimeograph duplicator to have the complete copy on the outside of the wrapper for reference purposes. The stencil is then removed from the Mimeograph duplicator, placed in the duplicated filing wrapper and filed by part number.

In the sample used for this case, twenty-three copies of the Production and Machine Tool Routing were run off. They were distributed to the various departments in the following way:

Department	No. of Copies	Disposition
Process Engineering	1	Filed
Tool Stores	1	Filed
Tool & Guage Design	1	Filed
Tool Crib	1	To have tools ready
Time Study & Plant Layout	3	One for each engineer concerned
Cumulative Standards	1	Filed
Manufacturing Departments	3	One for each department concerned
Production Control	1	For scheduling
Material Control	1	Filed
Tool & Guage Inspection	1	For tool histories

Department	No. of Copies	Disposition
Departmental Inspection	3	Filed-one for each department concerned
Receiving Inspection	2	For inspection in own plant & vendor plants
Chief Inspector	1	Filed
General Superintendent	1	Filed
Accounting	1	For checking cumulative standard time sheets
Suggestions	1	For checking suggested changes

When changes occur, the entire procedure is repeated as outlined above, up to the typing operation. The previously used stencil is drawn from the file and the change is incorporated in the routing by the typist. This is done by making a correction on the stencil if practical. If not practical, a new stencil is typed and the original destroyed.

5. The Barbour Stockwell Company

The Barbour Stockwell Company in Cambridge, Massachusetts, has a Bill of Materials (Figure 13) problem for which a Mimeographed solution has been suggested, but not yet adopted. It is not a large plant and they do operate on a very simple system.

The Foreman in each of the six manufacturing departments in the plant keeps a loose-leaf notebook. For

FOR: HATHAWAY MANUFACTURING CO. DATE 1-15-44

ORDER # 34287 DESCRIPTION: Firing Pin Assembly SHEET 1.

Drawing	Part	Name	Reqd	Mat	Patt	Ord	Rec	Shop	Comp	Notes
4364	333	Rausing Lever	1.	Steel	567	1-15	2-15	2-20	2-30	1.
4365	334	Box Beam Housing	2.	Steel	595	1-15	2-18	2-20	2-30	2.
4366	335	Brush Back Upper Part	4.	S#414	538	1-15	2-20	2-20	2-30	3.
4367	336	Ring	10.	Brass	525	1-15	2-30			4.
4368	337	Closing Disc	10.	Brass	538	1-15	2-29			5.
4369	338	Gas Sealing Regulator	3.	Alum.	516	1-15				6.

Figure 13

BARBOUR STOCKWELL CO. CAMBRIDGE, MASS.

B&B 12-43 1M

NOTES

1.

Each of these paragraphs describes the material to which it refers on the tracer. It gives specifications and manufacturing instructions.

2.

When a change is made on the tracer, the correspon ding paragraph in these notes is crossed out and a new one added with its proper number.

3.

When the job is originally made up,they Mimeograph six copies of the tracer and the notes. These are distributed to foremen of the six departments in the plant to be used as their work sheets.

4.

When a change is made, the stencil is taken out of file (see sample) changes are typed on it,the superceded lines are crossed out,and six new copies are run off.

5.

These new copies are sold to the interested foremen in the plant for their old copies. This rule must be adhered to rigidly to insure a proper working of the system. Otherwise the new sheets might be lost and the old sheets continued in use.

These copies are all kept in note books by each foreman in the different departments in the plant. The trouble with the system the way they worked it before was this.

These copies are all kept in note books by each foreman in the different departments in the plant. The trouble with the system the way they worked it before was this.

each job in the plant, he has a Bill of Materials accompanied by several pages of notes. The notes are numbered paragraphs of manufacturing or assembly information which refer to corresponding lines in the Bill of Materials. When a new job goes out into the plant, six copies of the Bill of Materials plus a page or two of notes are distributed to the foremen. These are placed in their notebooks and used as manufacturing instructions. The only difficulty with the system, as it is operated at present, is that it is necessary to take the books away from the foremen whenever a change has to be made in one of the Bills of Material. A change in the design of one of the parts, for instance, will mean that all of the books must be brought into the Plant Manager's office. Here a red pencil is drawn through the line or lines to be changed and new ones added below. New notes are typed on the accompanying pages and identified by number under the column headed "Notes" on the Bill of Materials and the superseded ones crossed out. Then, the notebooks are returned to the foremen, but in the meanwhile, they have been working in the dark, so to speak, without their books.

The suggested plan for improving this system was to have the Bill of Material put on a die-impressed stencil. Then when a new job was sent to the plant, six copies of the Bill of Materials and six copies of the notes would

be run off and distributed to the foremen, and the stencil filed. When a change came up (Figure 14), the stencil would be removed from the file folder. A stylus would be drawn through the lines to be deleted in the Bill of Materials and in the paragraph notes. The stencils would then be inserted in the typewriter and the new information added to them, after which they would be run off on the Mimeograph duplicator, and distributed to the various foremen. In order to avoid any possibility of negligence on the foremen's parts, which might result in a continued use of out-dated copies and a possible loss of the new ones, the policy was to be to sell the new copies, so to speak, to the foremen for their old ones. In this way, the foremen, no matter how rushed or lazy, would have to take the old copies out of their notebooks to get the new ones and so would be able to work only with the newest copies unless they chose to work with none at all.

FOR: HATHAWAY MANUFACTURING CO. DATE 1-15-44

ORDER # 34287 DESCRIPTION: Firing Pin Assembly SHEET 1.

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4364	333	Rausing Lever	1.	Steel	567	1-152	152-202	-30		1.
4365	334	Box Beam Housing	2.	Steel	595	1-152	182-202	-30		2.
4366	335	Brush Back Upper Part	4.	S#414	538	1-152	202-202	-30		3.
4367	336	Ring	10.	Brass	525	1-152	-30			4.
4368	337	Closing Disc	10.	Brass	538	1-152	-29			5.
4369	338	Gas Sealing Regulator	3.	Alum.	516	1-15				6.
4370	339	This is fictitious copy	5.	Paper	577	1-162	-303-1			7.
4371	340	Breaker Bar	1.	Zinc	576	1-163-1	3-2			8.

Figure 14

BARBOUR STOCKWELL CO. CAMBRIDGE, MASS.

B&B 12-43 1M

NOTES

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7.

Whenever a change had to be made, all the note books were called back into the production managers office. Here the changes were made

8.

This would take a whole day, and during this time the foremen had to work with out their books. This meant working in the dark with a consequent possibility of errors.

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Chapter VIII

Work Orders

1. The Ramsey Corporation

The Ramsey Corporation of St. Louis, Missouri, manufactures piston rings of approximately two thousand different sizes, in approximately eight basic styles. The controlling factors in the production of piston rings are diameter, width, and radial wall thickness. In using the Mimeograph duplicator to duplicate their Process Sheet, and Work Order (Figure 15), the Ramsey Corporation uses the one writing principle to produce the manufacturing information necessary to route an order through the plant.

A Production Request to manufacture is initiated in the Production Control Department, and can be initiated either from a customer order for a new ring or from inventory reaching the order point on a stock item, or from a customer's reorder. The Production Request is prepared in triplicate in pencil and includes such ordering data as quantity, diameter, width, kind, type, grinding procedure number, due date, etc.

One copy of the Production Request is routed from Production Control to Raw Material Stores as an order to obtain the required quantity of rough castings. These castings, in turn, are delivered to the receiving bay in the Grinding Department awaiting the first operation. The

SIZE 3 x 1/8 .020

TYPE Snap Oil Pin

MATERIAL

PART NAME: Ramco Piston Ring

PART NO.

MATERIAL DIMENSIONS | DRAWING NO. | PROCEDURE NO.: 496 Spec. | ROUTING TYPE: B

DEPT. NO.	MACH NO.	OP'N NO.	OPERATION DESCRIPTION	SPECIFICATIONS	TOOLS	STD. HRS.	PC'S PER HOUR	PIECES START	PIECES FIN.	OP'R NO.	DATE
		5C	Finish Grind	.1235-.1240							
		6	Slug	32-0-3.0930;005-035 End Cl							
		7	Rough Size	32-0-3.0730;005-015 End Cl	12-R-3.103						
		8A	Rough Turn	32-0-3.0400;005-015 End Cl	12-N-3.073						
		8B	Channel	.022 Min. Face Edge							
				.034-.039 Deep, .069 Wide	81-N.12375 x .069						
		9	Bore	.127-.131 Wall	12-U-3.045						
		10	Finish Turn	3.032 Diameter	12-N-3.040						
		11	Finish Size	32-0-3.0200;010-017 End Cl	54-0-3.040						
		12	Brooch	Pin Gauge							
		13	Oil Slot	9 Slots	.032 Saw 54-U-3.025						
				50% I.D. Ventilation							
		14	Inspect								
		15	Coat								

Figure 15

CC-3

WRITTEN BY: R.C. | DATE ISSUED 2-26-46 | SUPERSEDES | REMARKS: Pattern # H-3004A Turn Stock .0205 Bore Stock .0065

APPROVED BY: | CUSTOMER

second copy is forwarded to Methods Engineering and Method Engineering determines whether the Process Sheet is already available on a stock ring or for a previous customer's order, and if such is the case, the Request is then forwarded to the Mimeograph duplicating department with the Process Sheet number added to it so that the proper stencil can be withdrawn and copies of the Manufacturing Order then run.

If the request is for a new ring, Methods Engineering then prepares the Process Sheet and the Request is retained and forwarded with that Process Sheet. The third copy of the Request is retained at all times by Production Control. The operation layout of a new ring requires reference to the blue print or drawing and a check of the present master file of previous similar procedures. The Methods Engineer prepares a pencil copy of the Process Sheet on which he lists all operations, operation descriptions, specifications, tools, size, and type of ring, etc., and assigns a manufacturing procedure number.

In the case of the Ramsey Corporation, two Process Sheets are prepared. One Process Sheet is prepared covering all grinding operations, while a second Process Sheet is prepared covering all other operations, such as milling, turning and boring. The grinding procedures are few in number and it is not required that they be prepared for every new order. Because grinding operations are pre-

liminary, it is possible to assign the same grinding procedure to many types of rings. When new tools are required, Tool Engineering supplies the tool numbers for new tools. Methods Engineering rechecks the Process Sheet and forwards it to the Mimeograph duplicating department with the requisition.

2. Duplicating the Process Sheet

In the Mimeograph duplicating department, the typist receives the pencil copies of the Process Sheet and types the pencil information onto a Mimeograph die-impressed stencil. This stencil is considered the constant stencil as all data contained thereon has now become standard manufacturing procedure. The stencils are proof-read and are then ready for duplication. In the case of a stencil containing the grinding operations, it is duplicated without adding any variable order information such as the order number, quantity, due date, etc. A quantity of copies are duplicated and these copies are placed in file for use with future orders. Because of the manufacturing process of the Ramsey Corporation, it is only necessary to use one Tote Card or Travel Ticket with the rings as they go through the grinding operations. The rings at this time are contained in barrels or bags. After the grinding operations have been completed, the Inspection Department breaks the quantity down into lots and the rings are forwarded in Tote Pans

throughout the remainder of the manufacturing operations.

In duplicating the Process Sheet covering the milling, boring and turning operations, the stencil typist determines the number of Tote Pan Cards required, from a predetermined ring size chart. In other words, one Tote Pan is considered a lot; therefore, the quantity carried per Tote Pan divided into the total quantity ordered, determines the number of Tote Pans required. After this data has been obtained, a stencil is typed containing the variable ordering information. This consists of the lot number, quantity per lot, material and due date.

The variable and constant stencils are then placed on the Mimeograph duplicator and the required copies are duplicated. Tote Pan Cards, Master Record Cards, and the stencil filing wrapper are also duplicated with the aid of block-outs. The actual duplicating sequence is as follows: the constant stencil covering the milling, boring and turning operations is placed on the cylinder. This stencil does not cover the full width of the ink pad; therefore, a strip of paper approximately 1½"x11" is placed over the remaining exposed portion of the pad. The variable stencil has not yet been applied to the cylinder. The copies duplicated from this setup are as follows:

(1) CC-1, Stencil File Folder

(2) CC -2, Master Record Card

(3) CC-3, Works Manager's Reference Copy.

When these copies are duplicated, the strip of paper blocking out the ink pad is removed and placed over the stencil area at the lower part of the form blocking out the "Remarks" section. The variable stencil is then added so that the order number, quantity, due date, etc., are indicated on the Tote Tickets.

(4) CC-4, Work Order Copy is duplicated

(5) CC-5, CC-6, CC-7, and CC-8, Tote Pan tickets

(6) BB-1, the Process Sheet covering the grinding operations is then removed from the file and the variable information covering the lot number, quantity, material and due date are added by typewriter to this copy, which then becomes the grinding work order. Usually the due date is stamped with a large rubber stamp on all copies so that the due date is visibly outstanding.

3. Rerunning the Job

When more than one lot constitutes the order, the different lots are designated by using letters of the alphabet written in ink after the lot number. This corresponds with the alphabetic sequence indicated on the original Production Control Request and enables proper scheduling and control while the order is being processed through the plant. After all copies are duplicated, the constant stencil is removed from the Mimeograph duplicator and placed

in the file folder. The variable stencil is destroyed and all duplicated copies are checked to determine the order's completeness. It is at this time that the Tote Cards are marked as to lots.

The Mimeograph Duplicating Department then separates the copies, with the original pencil copy of the Process Sheet and the Master Record Card CC-2 forwarded to the Methods Engineering Department. A copy of the Process Sheet CC-3 and a Work Order Copy CC-4 are forwarded to the Works Manager. CC-4 is in turn routed to Scheduling. The Grinding Operation Work Order BB-1, plus sufficient Travel Cards (CC-5 through CC-8) for the Tote Box requirements are forwarded to Production Control along with the original Production Request A-2. The Grinding Operation Work Order and Travel Cards are then forwarded successively to the Grinding Department, Inspection and Piston Ring Department.

The Inspection Department after noting its first inspection on the Grinding Card divides the total quantity into lots and places a Travel Card with each lot. The Grinding Card is returned to Production Control to indicate completion of the grinding operations. The Inspection Department will also have indicated the quantity completed on the reverse side of the Grinding Card as the first inspection.

The lots then travel through all of the man-

ufacturing operations and each operator fills in on the travel cards his department number, machine number and clock number, plus pieces good and bad. Time cards are filled out by the operator against pieces good and are computed by the timekeeper. The time card is perforated and Scheduling receives a portion of the individual Time Card which closes out the operations. After the last operation, the completed rings are routed to Inspection. Upon completion of inspection, the Travel Card is sent to Scheduling to close out the lot. Then the Travel Card is forwarded to Production Control. The completed lot, in the meantime, has been forwarded to Finished Stores. It should be noted that in the design of the basic Process Sheet form, a space has been left between the columns headed "Operation Description" and "Specifications". This is allowed for future duplication of time cards.

Since Work Orders are the nub of all Production Control systems, the next chapter will be devoted to another Work Order in order to show how they vary even in similar industries.

Chapter IX

Work Orders (Continued)

1. The Allen Manufacturing Company

The Allen Manufacturing Company Work Order procedure[1] is interesting for several reasons. It shows some of the problems of rapid expansion, and it also shows how a really simple system can solve them. "Elimination of two clerks and a follow-up man, savings in identification tag costs, and saving through the elimination of errors" are among the direct results of the installation of a new production control system at the Allen Manufacturing Company. The system, which was started under the most hectic conditions-in fact, in the midst of war production-was designed to supply adequate and correct information; to eliminate the possibility of error; to be easy to understand by, and to have full support of, operating personnel.

Products of this company consist of hex socket setscrews, capscrews, shoulder screws, pipe plugs, dowel pins, and hex keys. In the combination of setscrew point styles (of which there are six), as well as screw diameters, lengths, coarse and fine thread series, there are 2760 items.

1. "Simplified Order Procedure Saves Time, Reduces Errors", by A.C.Crownfield,Jr., Production Superintendent, the Allen Manufacturing Company, Hartford, Connecticut. Factory Management and Maintenance, March 1946

During the period of war production, there were also approximately 2,000 open items of special specifications. On the average, about 4,000 items were in process at all times.

Operations include pressure forming, special automatic trimming, automatic machining, broaching, drawing, roll and cut threading, cutoff and bending, centerless grinding, cleaning and heat-treating. One piece may require as many as fifteen machine operations.

Scheduling for assembly is not a problem in screw manufacture. Since bills of material are therefore unnecessary, only individual pieces are ordered to be delivered to stock. Under the previous production order system, a stock item was started in production by issuing an order to the first operation. Routing to succeeding operations was written in on an identification tag at each operation. These travel tags were made out by clerk, toolsetter, or operator-whoever had the best opportunity at the necessary time. As long as operations were on a small scale, the system worked satisfactorily.

Under conditions of expansion to meet war demands and the call for many special items, it became necessary to supply the various operations with a copy of the routing. This procedure, in turn, required checking the department order file for routing information on each special item before making out the tag. As conditions changed,

they brought about turnover in personnel, new methods, and alternate routings to provide emergency service. Old knowledge became obsolete or lost with the change in personnel, new information developed too rapidly to be absorbed by new employees. There was danger of work being incorrectly routed, undesirable methods being used, unnecessary operations being performed, or work being lost or buried.

2. Planning a New Work Order

In planning the new work order system, much discussion of the problem took place in foremen's meetings and with personnel in both factory and office. By the time the system was fully developed, everyone interested had a part in working out some portion of it. Everyone knew what it would accomplish for him in the way of better results, with less mental irritation, less time, and less effort. All the problems involved in attaining objectives were known. The big task was in finding the means of producing identification traveler tags for the work pans, which would give a sufficient quantity of clear, distinct, and permanent copies.

The requirements for identification traveler tags (Figure 16) presented a problem because some orders require 200 pans or more. This is the result of ordering in quantities of 500,000 with maximum allowable pan loads of 65 pounds. Weight per pan is limited to reduce chances of injury from lifting. Tags must be durable and permanent

Stock Order No.	Scheduled To Start	Due Complete	Quantity Ordered
A-6626	6/14/45	8/25/45	10,000

Part Print No.	Size & Description
	SEE PROCESS SHEETS 10-32 X 1/2 FLAT PT. SET NF

Material Description	Deliver Material To	Material O.K.	Tools O.K.	Gages O.K.
.165 WIRE	LHA	X	X	X

Mat'l Ordered	Mat'l. Issued	Mat'l. Used	Maker	Grade	Heat No.

THE ALLEN MFG. CO.

2

Dept.	Operation	Std. Pcs. Per. Hr.	Date	Machine No.	Operator	Quantity
LHA	HEAD & RECESS SSR 145					
TSB	TRIM SSR 147					
TSB	POINT SSR 147					
UP	ROLL THREAD SSR 152					
DM	BROACH SSR 152					
UP	REROLL THREAD SSR 154					
AI	INSPECT SSR 154					
H	HEAT TREAT S					
	DELIVER TO 1ST FLOOR SCALES					

Figure 16

to withstand soaking in oil and smudging with oily, dirty fingers.

An electric model 92 Mimeograph duplicating machine, using a 1096k2 stubless die-impressed stencil of the form and hard-set ink, was used. This duplicator was chosen to make these traveler tags because:

1. It counts the copies automatically and stops printing at a predetermined quantity.

2. Possibility of error and loss of time occasioned by errors, are eliminated by use of a single stencil.

3. Clerical work in the factory is reduced considerably.

4. Unlimited copies of routing are available, including identification traveler tags, all clearly reproduced.

5. Impression is permanent regardless of oil smudges (tags must be burned to obliterate information).

6. It is practical to supply complete information regarding the work order and routing.

Fundamentally, the system adopted follows the pattern of an individual parts order. A brief description follows: the planning department to which all customer's orders are referred is responsible for scheduling and releasing all work orders to the plant. As the first step toward the preparation of the work order stencil, an order request is written up on a preduplicated form, made from a die-impressed stencil, which indicates also the various forms

which are made from this original stencil and filled in, just like the one later used for the work order, except that the heading "Order Request" has been inserted at the top and provision has been made for indicating sales volume for three, six, and twelve month periods. Sales volume is used as a guide in revising quantities to order. The number of identification traveler tags is indicated based on the number of tote pans required for the order.

The order file clerk, from permanent file information, fills in the minimum order quantity, size and description of the item, and order number on the order request (or stamps a previous control copy "Order Request"), and also fills in the sales quantities for the periods indicated. The order request is then sent to a scheduler, who checks the order quantity and the number of identification traveler tags required. The number of tags is based on a maximum sixty-five pound load per pan or the quantity produced per shift, if that is less than sixty-five pounds. The weight per hundred pieces is known and used to determine the pan and tag quantity.

The engineering department then adds the part print number, material description, operation sequence, and department for each operation. On repeat orders, this information is checked for changes in methods resulting in a routing change. If necessary, the stencil is corrected

before duplicating the papers. The stencil is so designed that the items which require the greatest number of changes on successive runs can be corrected most easily and often. It will be noted that the spaces in the top half of the form are three typewriter spaces deep, and since it is possible to make three corrections in one space, this form can be used for twelve different orders of the same item. The scheduler enters the date scheduled to start and complete the job. The availability of tools, gages, and material, is checked before the job is sent to the duplicating station to issue the order.

3. Distributing the Copies

At the duplicating station, the work order die-impressed stencil is typed, the required copies of the work order are duplicated, and proper distribution is made. The work order copies and the distribution and function of each are as follows.

The Order Control copy; duplicated on the back of a special preprinted form used by the order control department for posting progress and quantities completed.

The Return-To-Office copy; duplicated on white stock with a pre-printed heading. This copy is used for advance notice of the job to each department. It goes to the department performing the first operation. As soon as the job goes in work there, the start date is filled in

and the form is returned to the scheduler in order control. The scheduler records this information and sends the form to the department of the second operation, where it serves as an advance notice and is held until the job goes in work there, and so on.

The Job Record copies; duplicated on large yellow stock, preprinted at one end with columns for posting the dates, pieces completed, and rejects. One copy is duplicated for each department concerned with the manufacture of the part. These copies are used to record progress within the department and tend to prevent over-runs. They are returned to the scheduler as soon as each operation is completed. The scheduler posts the finish dates and checks quantities on the order control copy.

The identification traveler tags are duplicated on colored card stock. Each color denotes a different type of product. One tag is duplicated for each pan (as indicated on the Order Request). As the first operation is performed, an identification traveler tag is attached to each tote pan. An operator's ticket also accompanies each operator's lot to the counting station. This is a small printed tag used to give the operator credit for the day's work. It shows machine number, operations number, and description of work. At the end of each shift, the pans of work are sent to the counting and weighing station, where

the number of pieces completed is computed and entered on the operator's ticket and the identification traveler tag, before being moved to the next operation. The operator's tickets are accumulated at the counting station and sent to the order control section. Here, the daily production reports are written up and these data are posted to the control records to indicate progress. These data are used also in computing bonus averages by the standards and wage incentive department.

As soon as the copies are duplicated, the stencil is removed from the cylinder of the duplicator, cleaned in the stencil cleaning machine and filed in an oiled filing wrapper. Stencils are reused several times.

4. Repeat Orders

On repeat orders for a stock item, substantially the same procedure is followed. The stock record clerk stamps the old order control copy "Order Request" on the face of the form and indicates sales quantities for three, six, and twelve months, and the new order number. This form goes through the scheduling and engineering departments for revision or "okay". When the new schedule dates have been entered, it goes to the duplicating station, where the original stencil is removed from the file. The old order number, scheduled start, and completion dates are blocked out with correction fluid. The new information is

then filled in by typewriter, the stencil is attached to the duplicator, and the required number of copies are run off. The distribution is identical to that previously described.

For orders that require special materials, a material requisition is issued also. The material requisition is not issued for stock items, since the same type of material may be used on a number of orders. Two other factors contributing largely to the success of the installation are adequate written instructions and close supervisory control.

Written instructions are issued to make clear the key points on duties and responsibilities. The process handlers and the weigh men especially are instructed to turn back tickets that are incorrectly filled in. Supervisory control has not been difficult. Deviations from instructions are reported to the production superintendent. When errors are found, the cases are analyzed for causes and the information is used for correcting the condition or further training and education.

Chapter X

A Complete System

In the chapters preceding this one, only parts of a complete system of production control, as they demonstrated certain aspects of it, have been shown. Bills of Material, Process Sheets and Work Orders have been explained, and it has been shown how the copies were produced and what the function of each one was in the plant. Now, the method by which they can be welded together into a more complete system such as might be needed by a company which not only manufactures, but also assembles its own complete product will be discussed.

1. The A.B.Dick Company

A good beginning might be with a Parts List of Material Requirements (Figure 17). The company in this case is the A.B.Dick Company of Chicago. This particular Parts List, because it has to show so much information is produced on the Mimeograph 93 duplicator which has an extra large duplicating surface, and as can be seen from the sample, a die-impressed stencil is used. Across the top of the form are recorded the model assembly number, the name of the assembly, the date of original issue, and the chief engineer's name who has approved the job. The first three columns give a description of the piece parts which will be required to make the product. Column four shows the sub-assembly

A. B. DICK COMPANY
CHICAGO

PARTS LIST - MATERIAL REQUIREMENTS

DATE ORIGINAL ISSUE May 27, '43 NO. 1

APPROVED A. E. Newman
CHIEF ENGINEER

MODEL ASSMB. NO. 49728 NAME OF ASSEMBLY Steering Head:

LEGEND
M=MAKE F=BUY FIN. COMPLETE S=BUY SEMI-FIN.
D=DICK V=VENDOR C=CUSTOMER

SHEET OF

A. B. Dick Part No.	Customer's Part No.	PART NAME	First Sub Assembly	Quan. Per Unit	Make Buy M F S	Mat Furn. by D V C	MATERIAL DESCRIPTION MATERIAL	SIZE	SHAPE	QUAN. PER 100 PCS. Unit	Quan.	Spec. No.	Size, Shape, Code No.	C. M. P. Code No.	LINE
24945	1590525	Arm	24953A1	1	M	D	Stainless Steel Type 304	.0126 ± .001		lbs	.980	94	0528214	2531	3
24946	1590526	Boss	24947A	1	M	D	Aluminum Alloy 52S	.0508 ± .0025		lbs	.643	11	0326367	4311	6
24947	1590527	Arm	24947A	1	M	D	Aluminum Alloy 52S	.0508 ± .0025		lbs	1.891	11	0326368	4311	9
24948	1590528	Eccentric	24947A	1	F	V	Aluminum Alloy 17ST	.3125 ± .0015				11	01	4121	12
24949	1590530	Operating Pin	24947A	1	M	D	Aluminum Alloy 17ST	.125 ± .0015		lbs	.062	11	0117032	4121	15
24950	1590532	Pivot Bearing	24953A2	1	M	D	Stainless Steel Type 416	.156 ± .001		lbs	.325	96	0117042	2501	18
24951	1590534	Pivot Bushing (Short)	24953A1	1	M	D	Stainless Steel Type 416	.156 ± .001		lbs	.170	96	0117042	2501	21
24952	1590535	Reflector End Bracket	24953A1	2	M	D	Brass 1/2 Hard	.025 ± .0017		lbs	1.230	21	0328286	2501	24
24953	1590536	Reflector	24953A1	1	F	V	Ground Plate Glass								27
24954	1590537	Pivot Bushing (Long)	24953A1	1	M	D	Stainless Steel Type 416	.187 ± .001 Square		lbs	.695	96	0117497	2501	30
24955	1590542	Cover Plate	24953A2	1	M	D	.0253 - .002 Aluminum Alloy 17ST or 24ST opt.			lbs	10.700	11	0128287	4311	33
24956	1590543	Reflector Support Brkt.	24941A	1	S	D	Aluminum Alloy Die Casting AC 13 or AC 15			lbs		10	01	4207	36
24957	1592814	Fillister Head Screw	24941A	3	F	V	Stainless Steel Type 416 or 410					96	01	2501	39
24958	1590918	Nut	24953A2	1	F	V	Stainless Steel Type 303					94	03	2501	42
24959	1591305	Pin		3	F	V	Stainless Steel Type 303	.110 - .0003				94	03	2501	45
			24941A	2											46
			24505A2	1											49

APPROVED CHIEF ENGINEER

CHANGE DATES

Figure 17

where each part will be used before it goes into the final assembly. Column five shows the number of piece parts which will be required to make up one of the product. Column six shows the source of each piece part; whether it is manufactured in the plant, purchased as a finished article or purchased in a semi-finished condition. Column seven shows the source of raw material. The legend in the heading of the form refers to both columns six and seven. Columns eight, nine, ten, and eleven give a description of each item showing the quantity and the specifications of the raw materials required. Column twelve shows the C.M.P. or Code number under which Material is classified for Purchase. Across the bottom of the form are spaces where the chief engineer signs his initials and the date whenever an engineering change is made in the product.

The engineering department creates this catalogue of parts required to make the product, and the material from which these parts will be made; but first production prints are prepared from prints received from the Engineering Design Group or from the outside firm for which sub-contracting is being done. From these production prints, information is taken for the preparation of the Master Parts List and Bill of Materials form. Each part, treated separately, is listed on the form in a single line until such time as all single-piece parts which will be required to complete the product have been listed. All information common

to the part is included in the form.

2. Distribution of Copies

Nearly all departments within a plant are concerned with this list and the copies are distributed as follows:

1. Material Control, has a record of what is needed, what will be manufactured, and must be purchased to make the product.

2. Product Engineering, has a permanent record of the part and the material sources, specification and the quantities required to make the product.

3. Process Engineering, knows what parts will be bought and what parts made, thus insuring faster action on all parts to be manufactured.

4. Production Control, has full information on piece parts requirements which helps to simplify scheduling.

5. Purchasing Department, has full knowledge of all part requirements and is able to minimize the possibility of error.

6. Outside Expediting, knows all parts and materials to be purchased, and can therefore function more effectively.

7. Stores Division, knows sequence of part requirements for assemblies, and can stock parts for more efficient handling.

So with each of these departments properly

informed by means of this Parts List, their work is co-ordinated and assignments are expedited, helping to get the job into the factory sooner.

For the individual parts which are to be manufactured or finished in the plant, a Process Sheet for each part will be necessary. Again this is done on a die-impressed stencil. In the heading of the form are recorded the part number, part name and the number of the sub-assembly on which the part will be used, the names of the persons responsible for the form, the date, and the date the job is to be released to Production Control, a material description, material specification number, material code number, and spaces for an engineering change order number and date.

3. The Operation Routing Sheet

The Engineering Department determines from the blueprint the operations necessary and the sequence in which they will be performed, to fabricate the raw material into the finished part. This information is then entered on the Operation Routing Sheet (Figure 18). The sequence of the operations is identified in the column headed "Operation Number". The work to be done in each operation is described in the column "Operation Description". The next three columns, Department, Group, Machine, tell where the work is to be done. In the column "Tools, Jigs and Fixtures", the machine on which the operation will be done is described

--

PROCESS SHEET - SPECIFICATIONS & ROUTING

SHEET 1 OF 1

PART NO.	PART NAME	SUB. ASSMB. USED ON	RELEASE APPROVAL / ENG. RELEASE
33018	GUARD	33000	A.E.N.

WRITTEN BY	CHECKED BY	APPROVED	DATE	DATE RELEASED TO PROD. CONTROL
NAVARRD	E.J.MILLER	H.J.D.	5-31-43	5-26-43

MATERIAL DESCRIPTION	MAT. SPEC. NO.	MAT. CODE NO.	ENG. CHANGE ORDER NO.	ENG. CHANGE DATE
.032 x 2 3/8 x 3 3/8 -52-S AL.ALLOY (PINK-BLUE)	1103	26333		

OPER. NO.	OPERATION DESCRIPTION	DEPT.	GROUP	MACH.	EQUIPMENT DESCRIPTION — TOOL, JIG, GAGE OR FIXTURE NUMBER & DESCRIPTION	PIECES PER HR.	STD. HRS. PER 100 PIECES
1	PIERCE AND BLANK	414	6	517	#3½ TOLEDO PUNCH PRESS PIERCING AND BLANKING P & D	600	.166
					T.41624 BOLSTER 1003		
2	FORM	414	6	1181	#3½ TOLEDO PUNCH PRESS FORMING P & D 41625	333	.300
					BOLSTER 1001 CHECKING GAUGE 48695		
3	BURR AND WASH	440			POLISHING JACK TANK	200	.5
4	INSPECT	475			BENCH CHECKING GAUGE 48695	200	.500
5	ANODIZE AS PER SPEC. #26 (SEND OUTSIDE)						

DATE OF LAST PREVIOUS CHANGE

Figure 18

CLASS	STD. SET-UP TIME	NORMAL MCH. HRS. PER 100 PCS.	NORMAL MAN HRS. PER 100 PCS.
T	.5	.166	.166
T	.5	.300	.300
T	-	-	.500
T	-	-	.500

(such as Browne & Sharpe screw machine, or Cincinnati milling machine) and the tools, jigs, fixtures and guages required to perform the operation, with identifying names and numbers, are listed for each operation.

When time study information is available, it is possible to determine the estimated time required to do the operation. The Time Study Engineer may add the estimated time required to the operation routing sheet. Reference is frequently made to the Engineering Cost Estimating Department's figures, which are usually prepared to determine the estimated cost of a part. When tools are completed, they can be run for test purposes. Operations are then actually time studied, which will result in standards of a high degree of accuracy. The time study information is listed on the form under the proper heading, such as Pieces per Hour, or Normal Man Hours.

Again, when time-study information is available, operation by operation, the scheduled start and due dates can be fixed. Hours to be assigned to various departments can be determined, and if desired, standard costs, based on standard hours can be established. Projected loads are made possible, which visualizes most accurately what is assigned to the plant, by departments, for the ensuing six months, or any desired period of time. The form is so designed that the information required by the Engineering De-

SCHEDULING DEPARTMENT

PART NAME	LOT	QUAN.	START DATE	DUE DATE	JOB NO.	WORK ORDER NO.
Pivot Bearing 24950	1	500	6-10-43	6-30-43	7985	10007

MATERIAL	SPEC. NO.	CODE NO.	QUAN.	UNIT	TOTAL	RATE	COST
.156"-.001" Stn. Steel Type #416	9601	1704	2.6	lbs.			

PART NO.	OPR. NO.	DEPT. NO.	MACHINE GROUP NO.	TOTAL OPR. HOURS		START DATE	DUE DATE	PIECES GOOD	PIECES REJECT	INSPECTOR	DATE
24950	1	400			050	6-10-43	6-10-43				
24950	2	410			645	6-10-43	6-11-43				
24950	3	440			125	6-11-43	6-12-43				
24950	4	410	1269	12	500	6-14-43	6-15-43				
24950	5	410	1269	12	500	6-16-43	6-17-43				
24950	6	413	533	20	000	6-18-43	6-22-43				
24950	7	440			125	6-23-43	6-24-43				
24950	8	476		16	700	6-24-43	6-28-43				
24950	9	440			165	6-29-43	6-30-43				
24950	10	476		6	300	6-30-43	6-30-43				

1600	1800	2000	100		300	500	700	900	1000	1500	1400
					500	500 500	500 500				
JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.

PART NO. 24590 PART NAME PIVOT BEARING QUAN 500 START 5-1943 DUE 4-1944 MODEL S-H

Figure 19

to make a given number of the product during any period of time. For example, if Part No.1000 is used two times on a product and if it is planned to build 200 of this product each month for the ensuing six months, a quantity of 400 of Part No.1000 will be required each month. The necessary amount of time must be allowed for manufacturing or purchasing the proper quantity of each part. Therefore, commitment figures or requirement figures must be interpreted into production or schedule figures.

To illustrate: it has been determined that 400 units of Part No.1000 will be required each month. The visible card may show that part number 1000 is manufactured in lot quantities of 400, requiring a travel time or manufacturing time of five days per lot, and a preparatory time of twenty days. That is to say, time for the advance release of orders, and tools, etc., and also time for material procurement. The first lot of 400 is therefore scheduled for manufacture twenty-five days before the date on which it will be required.

A visible tab is placed on the card for part number 1000 at the date when the first lot is to be released. This insures prompt scheduling of the first lot and, similarly, of all following lots. When an order for part number 1000 is released to the shop, the date of order, number of order and pieces requested are posted to the "In" part of

the card. A copy of the work order, identified as Scheduling Department, is filed with the card and, as operation completion notices are received, information taken from them is posted to the scheduling copy.

The Final inspection notice closes out the order, and shows date of completion, number of pieces good, and rejects. This information is posted to the"Out" part of the card. By subtracting Pieces Good from Balance Due (total number required to complete the order), there is positive information as to the question, "Where do we stand on the order?" Constant control is easily maintained because the completion notices and the inspection notices produced on the Mimeograph duplicator, feed back the necessary information.

5. Releasing the Job to the Plant

When all preproduction work is completed, including Product Engineering (Master Parts List and Bill of Material, Process Engineering Operation-Routing Sheet), Tool Design, Tool Fabrication, etc., and with determined schedule dates established, the time arrives for a lot quantity of the part to be released to the plant for fabrication. The visible record shows the time when an order for any part is to be released for manufacture. From the visible index jacket and the Operation-Routing Sheet, all information needed for preparing the shop order is available. This is quickly

typed onto a form-topped stencil sheet, and copies duplicated. This paper work initiates all major production functions.

All information pertinent to the order is written only once on the stencil sheet. Then collated sets of the forms are placed on the feed table of the Mimeograph duplicator, the stencil is attached, and copies are quickly reproduced. Errors, caused by lack of information, or by information incorrectly copied,are eliminated. High legibility and permanence of copy contribute to efficiency and accuracy in the shop. When the copies have been produced, their distribution is as follows.

1. Departmental Notice (Figure 20). All departments are notified in advance, by this form, that the assigned work is en route and should be completed by the specified date. Orderly procedure results in each department concerned. Since the departments have advance notification of future work, they can prepare for that work.

2.Scheduling Department (Figure 19). The progress record is duplicated from the Work Order stencil. Its purpose is to accumulate progress data showing movement of material from operation to operation. It shows, at a moment's notice, exactly where the job is in the shop.

3. Material Requisition (Figure 21). The Material Request form, also duplicated from the one writing, is sent to Raw Stores with the Raw Material Tag. An identical copy goes

DEPARTMENT WORK ORDER

PART NAME	LOT	QUAN.	START DATE	DUE DATE	JOB NO.	WORK ORDER NO.
Pivot Bearing 24950	1	500	6-10-43	6-30-43	7985	10007

MATERIAL	SPEC. NO.	CODE NO.	QUAN.	UNIT	TOTAL	RATE	COST
.156"-.001" Stn. Steel Type #416	9601	1704	2.6	lbs.			

PART NO.	OPR. NO.	DEPT. NO.	MACHINE GROUP NO.	TOTAL OPR. HOURS		START DATE	DUE DATE	PIECES GOOD	PIECES REJECT	INSPECTOR	DATE
24950	1	400			050	6-10-43	6-10-43				
24950	2	410			645	6-10-43	6-11-43				
24950	3	440			125	6-11-43	6-12-43				
24950	4	410	1269	12	500	6-14-43	6-15-43				
24950	5	410	1269	12	500	6-16-43	6-17-43				
24950	6	413	533	20	000	6-18-43	6-22-43				
24950	7	440			125	6-23-43	6-24-43				
24950	8	476		16	700	6-24-43	6-28-43				
24950	9	440			165	6-29-43	6-30-43				
24950	10	476		6	300	6-30-43	6-30-43				

Form F463

Figure 20

MATERIAL REQUISITION

OLD BALANCE	AMT. ORDERED	NEW BALANCE

PART NAME	LOT	QUAN.	START DATE	DUE DATE	JOB NO.	WORK ORDER NO.
Pivot Bearing 24950	1	500	6-10-43	6-30-43	7985	10007

MATERIAL	SPEC. NO.	CODE NO.	QUAN.	UNIT	TOTAL	RATE	COST
.156"-.001" Stn. Steel Type #416	9601	1704	2.6	lbs.			

PART NO.	OPR. NO.	DEPT. NO.	MACHINE GROUP NO.	TOTAL OPR. HOURS		START DATE	DUE DATE	PIECES GOOD	PIECES REJECT	INSPECTOR	DATE
24950	1	400			050	6-10-43	6-10-43				
24950	2	410			645	6-10-43	6-11-43				
24950	3	440			125	6-11-43	6-12-43				
24950	4	410	1269	12	500	6-14-43	6-15-43				
24950	5	410	1269	12	500	6-16-43	6-17-43				
24950	6	413	533	20	000	6-18-43	6-22-43				
24950	7	440			125	6-23-43	6-24-43				
24950	8	476		16	700	6-24-43	6-28-43				
24950	9	440			165	6-29-43	6-30-43				
24950	10	476		6	300	6-30-43	6-30-43				

SEND ABOVE LISTED MATERIAL TO THE DEPARTMENT FOR OPERATION NO. 1

DATE DELIVERED _____ DATE WANTED _____

SIGNED _____ SIGNED _____

Form F462 STOREKEEPER MATERIAL CONTROL

Figure 21

to Material Control, thus insuring an accurate recording of raw material disbursed. Errors in handling raw material are obviously minimized.

4. Raw Material Tag (Figure 22) is attached by the Raw Stores Clerk, and properly identifies and routes the raw material to the department that will perform the first operation. The quantity and description of the material appear on all the Work Order paper work.

5. Material Traveler (Figure 23). As the raw material is routed through the shop, several boxes are usually required to convey the material from department to department. With the contents of each box identified by Tote Box Tickets or Tags, it is unlikely that any part of the lot will be misrouted or delayed. This precautionary method has proved very worthwhile, frequently saving valuable manufacturing time.

6. Department Work Order (Figure 24). The Work Order, with a copy of the Operation-Routing Sheet and the blueprint, is carried in a traveler jacket. The traveler jacket and its contents start the work on the first operation, telling what is to be done, tools required, length of time allotted for the operation, etc. Pertinent information is accumulated on the traveler copy of the shop order as material moves from department to department. Thus it reflects a continuous, up to the minute record of what has actually

RAW MATERIAL TAG

PART NAME	LOT	QUAN.	START DATE	DUE DATE	JOB NO.	WORK ORDER NO.
Pivot Bearing 24950	1	500	6-10-43	6-30-43	7985	10007

MATERIAL	SPEC. NO.	CODE NO.	QUAN.	UNIT	TOTAL	RATE	COST
.156"-.001" Stn. Steel Type #416	9601	1704	2.6	lbs.			

PART NO.	OPR. NO.	DEPT. NO.	MACHINE GROUP NO.	TOTAL OPR. HOURS		START DATE	DUE DATE	PIECES GOOD	PIECES REJECT	INSPECTOR	DATE
24950	1	400			050	6-10-43	6-10-43				
24950	2	410			645	6-10-43	6-11-43				
24950	3	440			125	6-11-43	6-12-43				
24950	4	410	1269	12	500	6-14-43	6-15-43				
24950	5	410	1269	12	500	6-16-43	6-17-43				
24950	6	413	533	20	000	6-18-43	6-22-43				
24950	7	440			125	6-23-43	6-24-43				
24950	8	476		16	700	6-24-43	6-28-43				
24950	9	440			165	6-29-43	6-30-43				
24950	10	476		6	300	6-30-43	6-30-43				

DELIVER THIS MATERIAL TO THE DEPARTMENT FOR OPERATION NO. 1

Form F468

Figure 22

MATERIAL TRAVELER

PART NAME	LOT	QUAN.	START DATE	DUE DATE	JOB NO.	WORK ORDER NO.
Pivot Bearing 24950	1	500	6-10-43	6-30-43	7985	10007

MATERIAL	SPEC. NO.	CODE NO.	QUAN.	UNIT	TOTAL	RATE	COST
.156"-.001" Stn. Steel Type #416	9601	1704	2.6	lbs			

PART NO.	OPR. NO.	DEPT. NO.	MACHINE GROUP NO.	TOTAL OPR. HOURS		START DATE	DUE DATE	PIECES GOOD	PIECES REJECT	INSPECTOR	DATE
24950	1	400			050	6-10-43	6-10-43				
24950	2	410			645	6-10-43	6-11-43				
24950	3	440			125	6-11-43	6-12-43				
24950	4	410	1269	12	500	6-14-43	6-15-43				
24950	5	410	1269	12	500	6-16-43	6-17-43				
24950	6	413	533	20	000	6-18-43	6-22-43				
24950	7	440			125	6-23-43	6-24-43				
24950	8	476		16	700	6-24-43	6-28-43				
24950	9	440			165	6-29-43	6-30-43				
24950	10	476		6	300	6-30-43	6-30-43				

RECORD OF SPLIT LOT	SPLIT LOT NO. OF	QUAN.	REMARKS

WHEN OPERATION IS COMPLETED MARK OUT AND FORWARD MATERIAL TO NEXT DEPARTMENT

Form F461

Figure 23

SHOP TRAVELER

PART NAME	LOT	QUAN.	START DATE	DUE DATE	JOB NO.	WORK ORDER NO.
Pivot Bearing 24950	1	500	6-10-43	6-30-43	7985	10007

MATERIAL	SPEC. NO.	CODE NO.	QUAN.	UNIT	TOTAL	RATE	COST
.156"-.001" Stn. Steel Type #416	9601	1704	2.6	lbs.			

PART NO.	OPR. NO.	DEPT. NO.	MACHINE GROUP NO.	TOTAL OPR. HOURS		START DATE	DUE DATE	PIECES GOOD	PIECES REJECT	INSPECTOR	DATE
24950	1	400			050	6-10-43	6-10-43				
24950	2	410			645	6-10-43	6-11-43				
24950	3	440			125	6-11-43	6-12-43				
24950	4	410	1269	12	500	6-14-43	6-15-43				
24950	5	410	1269	12	500	6-16-43	6-17-43				
24950	6	413	533	20	000	6-18-43	6-22-43				
24950	7	440			125	6-23-43	6-24-43				
24950	8	476		16	700	6-24-43	6-28-43				
24950	9	440			165	6-29-43	6-30-43				
24950	10	476		6	300	6-30-43	6-30-43				

Form F467

Figure 24

taken place in the shop. Posting to this form serves as move authority and identifies the department that will perform the next operation.

7. Tool Withdrawal Slip (Figure 25). No rewriting of necessary information on the tool withdrawal slip. When submitted to the tool crib, the proper tools are dispatched to the correct department for setup to handle the assigned job.

8. Time Tickets. When the worker is ready to start the job, he writes his clock number and name on a time ticket also produced from the single writing of the work order. This is inserted into the time clock, which records the time when the job was started. Since this time ticket has nearly all the needed information already duplicated on it, the necessity for many pencil extensions is largely eliminated, thus resulting in minimum error and waste of time.

9. Operation Completion Notices (Figure 26). The completion notice conveys to the Scheduling and Cost Departments information as to when operation number one, two, and three, etc., has been completed. It shows the quantity accepted and rejected at each point. Cost Records, Department and Machine Group Load Reports are thereby accurately kept and are always up to date.

10. Final Part Inspection (Figure 27). The final part inspection group closes out the order, showing the parts

TOOL WITHDRAWAL

PART NAME	LOT	QUAN.	START DATE	DUE DATE	JOB NO.	WORK ORDER NO.
Pivot Bearing 24950	1	500	6-10-43	6-30-43	7985	10007

MATERIAL	SPEC. NO.	CODE NO.	QUAN.	UNIT	TOTAL	RATE	COST
.156"-.001" Stn. Steel Type #416	9601	1704	2.6	lbs.			

PART NO.	OPR. NO.	DEPT. NO.	MACHINE GROUP NO.	TOTAL OPR. HOURS		START DATE	DUE DATE	PIECES GOOD	PIECES REJECT	INSPECTOR	DATE
24950	1	400			050	6-10-43	6-10-43				
24950	2	410			645	6-10-43	6-11-43				
24950	3	440			125	6-11-43	6-12-43				
24950	4	410	1269	12	500	6-14-43	6-15-43				
24950	5	410	1269	12	500	6-16-43	6-17-43				
24950	6	413	533	20	000	6-18-43	6-22-43				
24950	7	440			125	6-23-43	6-24-43				
24950	8	476		16	700	6-24-43	6-28-43				
24950	9	440			165	6-29-43	6-30-43				
24950	10	476		6	300	6-30-43	6-30-43				

☐ TOOL CRIB ☐ TOOL DESIGN

MAKE ENTRIES INDICATED ON REVERSE SIDE

Form F460

Figure 25

OPERATION COMPLETION NOTICE

PART NAME	LOT	QUAN.	START DATE	DUE DATE	JOB NO.	WORK ORDER NO.
Pivot Bearing 24950	1	500	6-10-43	6-30-43	7985	10007

MATERIAL	SPEC. NO.	CODE NO.	QUAN.	UNIT	TOTAL	RATE	COST
.156"-.001" Stn. Steel Type #416	9601	1704	2.6	lbs.			

PART NO.	OPR. NO.	DEPT. NO.	MACHINE GROUP NO.	TOTAL OPR. HOURS		START DATE	DUE DATE	PIECES GOOD	PIECES REJECT	INSPECTOR	DATE
24950	1	400			050	6-10-43	6-10-43				
24950	2	410			645	6-10-43	6-11-43				
24950	3	440			125	6-11-43	6-12-43				
24950	4	410	1269	12	500	6-14-43	6-15-43				
24950	5	410	1269	12	500	6-16-43	6-17-43				
24950	6	413	533	20	000	6-18-43	6-22-43				
24950	7	440			125	6-23-43	6-24-43				
24950	8	476		16	700	6-24-43	6-28-43				
24950	9	440			165	6-29-43	6-30-43				
24950	10	476		6	300	6-30-43	6-30-43				

AFTER COMPLETION OF OPERATION AND INSPECTED COUNT SEND TO

☐ TABULATING DEPT. ☐ SCHEDULE DEPT. ☐ COST DEPT.

NOTE. RETURN ALL UNUSED TIME CARDS WITH THIS COMPLETION NOTICE

Form F464

Figure 26

FINAL PART INSPECTION

PART NAME	LOT	QUAN.	START DATE	DUE DATE	JOB NO.	WORK ORDER NO.
Pivot Bearing 24950	1	500	6-10-43	6-30-43	7985	10007

MATERIAL	SPEC. NO.	CODE NO.	QUAN.	UNIT	TOTAL	RATE	COST
.156"-.001" Stn. Steel Type #416	9601	1704	2.6	lbs.			

PART NO.	OPR. NO.	DEPT. NO.	MACHINE GROUP NO.	TOTAL OPR. HOURS		START DATE	DUE DATE	PIECES GOOD	PIECES REJECT	INSPECTOR	DATE
24950	1	400			050	6-10-43	6-10-43				
24950	2	410			645	6-10-43	6-11-43				
24950	3	440			125	6-11-43	6-12-43				
24950	4	410	1269	12	500	6-14-43	6-15-43				
24950	5	410	1269	12	500	6-16-43	6-17-43				
24950	6	413	533	20	000	6-18-43	6-22-43				
24950	7	440			125	6-23-43	6-24-43				
24950	8	476		16	700	6-24-43	6-28-43				
24950	9	440			165	6-29-43	6-30-43				
24950	10	476		6	300	6-30-43	6-30-43				

DATE	QUAN. SUBM'T'D	QUAN. ACCPT.	QUAN. REJ.	REJ. TAG NO.	REASON FOR REJECT	INSPECTOR

DISPATCHER

Form F465 in quin.

Figure 27

FINAL PART INSPECTION

PART NAME	LOT	QUAN.	START DATE	DUE DATE	JOB NO.	WORK ORDER NO.
Pivot Bearing 24950	1	500	6-10-43	6-30-43	7985	10007

MATERIAL	SPEC. NO.	CODE NO.	QUAN.	UNIT	TOTAL	RATE	COST
.156"-.001" Stn. Steel Type #416	9601	1704	2.6	lbs.			

PART NO.	OPR. NO.	DEPT. NO.	MACHINE GROUP NO.	TOTAL OPR. HOURS		START DATE	DUE DATE	PIECES GOOD	PIECES REJECT	INSPECTOR	DATE
24950	1	400			050	6-10-43	6-10-43				
24950	2	410			645	6-10-43	6-11-43				
24950	3	440			125	6-11-43	6-12-43				
24950	4	410	1269	12	500	6-14-43	6-15-43				
24950	5	410	1269	12	500	6-16-43	6-17-43				
24950	6	413	533	20	000	6-18-43	6-22-43				
24950	7	440			125	6-23-43	6-24-43				
24950	8	476		16	700	6-24-43	6-28-43				
24950	9	440			165	6-29-43	6-30-43				
24950	10	476		6	300	6-30-43	6-30-43				

DATE	QUAN. SUBM'T'D	QUAN. ACCPT.	QUAN. REJ.	REJ. TAG NO.	REASON FOR REJECT	INSPECTOR

TABULATING

Form F465 in quin.

FINAL PART INSPECTION

PART NAME	LOT	QUAN.	START DATE	DUE DATE	JOB NO.	WORK ORDER NO.
Pivot Bearing 24950	1	500	6-10-43	6-30-43	7985	10007

MATERIAL	SPEC. NO.	CODE NO.	QUAN.	UNIT	TOTAL	RATE	COST
.156"-.001" Stn. Steel Type #416	9601	1704	2.6	lbs.			

PART NO.	OPR. NO.	DEPT. NO.	MACHINE GROUP NO.	TOTAL OPR. HOURS		START DATE	DUE DATE	PIECES GOOD	PIECES REJECT	INSPECTOR	DATE
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24950	4	410	1269	12	500	6-14-43	6-15-43				
24950	5	410	1269	12	500	6-16-43	6-17-43				
24950	6	413	533	20	000	6-18-43	6-22-43				
24950	7	440			125	6-23-43	6-24-43				
24950	8	476		16	700	6-24-43	6-28-43				
24950	9	440			165	6-29-43	6-30-43				
24950	10	476		6	300	6-30-43	6-30-43				

DATE	QUAN. SUBM.T'D	QUAN. ACCPT.	QUAN. REJ.	REJ. TAG NO.	REASON FOR REJECT	INSPECTOR

INSPECTION

Form F465 in quin.

FINAL PART INSPECTION

PART NAME	LOT	QUAN.	START DATE	DUE DATE	JOB NO.	WORK ORDER NO.
Pivot Bearing 24950	1	500	6-10-43	6-30-43	7985	10007

MATERIAL	SPEC. NO.	CODE NO.	QUAN.	UNIT	TOTAL	RATE	COST
.156"-.001" Stn. Steel Type #416	9601	1704	2.6	lbs.			

PART NO.	OPR. NO.	DEPT. NO.	MACHINE GROUP NO.	TOTAL OPR. HOURS		START DATE	DUE DATE	PIECES GOOD	PIECES REJECT	INSPECTOR	DATE
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24950	7	440			125	6-23-43	6-24-43				
24950	8	476		16	700	6-24-43	6-28-43				
24950	9	440			165	6-29-43	6-30-43				
24950	10	476		6	300	6-30-43	6-30-43				

DATE	QUAN. SUBM'T'D	QUAN. ACCPT.	QUAN. REJ.	REJ. TAG NO.	REASON FOR REJECT	INSPECTOR

COST DEPT.

Form F465 in quin.

FINAL PART INSPECTION

PART NAME	LOT	QUAN.	START DATE	DUE DATE	JOB NO.	WORK ORDER NO.
Pivot Bearing 24950	1	500	6-10-43	6-30-43	7985	10007

MATERIAL	SPEC. NO.	CODE NO.	QUAN.	UNIT	TOTAL	RATE	COST
.156"-.001" Stn. Steel Type #416	9601	1704	2.6	lbs.			

PART NO.	OPR. NO.	DEPT. NO.	MACHINE GROUP NO.	TOTAL OPR. HOURS		START DATE	DUE DATE	PIECES GOOD	PIECES REJECT	INSPECTOR	DATE
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24950	2	410			645	6-10-43	6-11-43				
24950	3	440			125	6-11-43	6-12-43				
24950	4	410	1269	12	500	6-14-43	6-15-43				
24950	5	410	1269	12	500	6-16-43	6-17-43				
24950	6	413	533	20	000	6-18-43	6-22-43				
24950	7	440			125	6-23-43	6-24-43				
24950	8	476		16	700	6-24-43	6-28-43				
24950	9	440			165	6-29-43	6-30-43				
24950	10	476		6	300	6-30-43	6-30-43				

DATE	QUAN. SUBM'T'D	QUAN. ACCPT.	QUAN. REJ.	REJ. TAG NO.	REASON FOR REJECT	INSPECTOR

SCHEDULING

Form F465 in quin

finally submitted for inspection and stating what is accepted and what is rejected. A four part form conveys this information to those departments concerned; Cost Department, Dispatcher, Material Control, and Inspection File. The continuous flow of cost information to the cost department avoids peak loads in the department and insures prompt and accurate information. The cost department sets up a cost ledger sheet covering the lot. From a copy of the material request, the raw material cost is posted to the ledger sheet. Time tickets for each worker who performs work on each operation, flow to the cost department, and the direct labor charge is posted to the ledger sheet. This enables the cost department to make accurate lot costs and operation costs for each part and assembly.

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Chapter XI

Variations from the Conventional Installation

1. The Billings and Spencer Company

Chapter Ten describes a complete system of production control, and yet there are variations and additions which are used in other systems which should be explained in this chapter. In connection with the Shop Order forms in general, and the Material Traveler in particular, there is a form used quite generally known as a Split Lot Traveler or Split Lot Route Card as it is called by the Billings and Spencer Company of Hartford, in their system. Perhaps the best way to show how it fits into their work is to explain their whole production procedure set up.

The procedure was worked out to make it easier for all concerned to identify work in the shop by the same designations as previously used; especially steel heat numbers. It facilitated the work, and to a great degree eliminated pencil copy work, thus relieving repetition of effort on the worker's part. There is a Route Card (Figure 28) which accompanies the work at all times, which should never be removed from the work (excepting the period of the heat treating process). The steel heat number is printed on this card and no one has to re-copy it. The object of this card is to identify the work properly, to route it in a regular sequence of operations, and to move the work

FORM NO. 796

SPLIT LOT ROUTE CARD

THE BILLINGS AND SPENCER COMPANY

Customer	Total Quan. Ordered	Order No.	Ident. No.
NORTH AMERICAN AVIATION CO. INGLEWOOD, CAL.	4750	C-6136	A-13782
		Customer Ord. No. 431-65041	Lot No. / Split No.

Steel Spec.	Heat No.	Sym.	Grade	Class Scrap	Lot Quan.
AN-QQ-S-646	12541		X1020		

Heat Treat Spec. NORMALIZE

Instructions RATE AA-1 CONT.NA 109- CMP-C-1
2Q44-WAR ORD.(NA-109)W535-AC-40064
C-1-4Q43- 954#- 1044- 1478#- 2044- 1226#

ALWAYS KEEP THIS CARD WITH WORK

Part	Hammer		Ident. No.
FGS: B/P 62-58251-CRANK HYD. LANDING GEAR & COWL FLAP VALVE CONTROL	1000#	1	A-13782

Customer	Grade	Steel Size	Rough Wt.	Fin. Wt.
NORTH AMERICAN AVIA.	X1020	15/16"RD	70#	55#

Prod. Planning Dept. Must Issue SPLIT LOT ROUTE CARD For All Splits

Split 1	Quan.	From	To	Split 3	Quan.	From	To
Split 2				Split 4			

Symbol	Operations	Date	Clerk	Quan.	Scrap	Repair
	14-A-T-G-F-H-76-PROD					
A-447	FORGE					
T-993	TUMBLAST					
G-880	TRIM					
G-333	COIN					
F-118	GRIND FLASH					
F-112	BURR INSIDE					
H-669	NORMALIZE					
T-993-2	TUMBLAST					
G-889	MAGNAFLUX & INSP					
T-993-2	TUMBLAST					
	SEND TO 76					

Figure 28

without the use of move tickets.

Accompanying the route card is a set of Completion Notices with at least one Completion Notice for each operation to be performed. The Route Card and Completion Notices are enclosed in a heavy transparent envelope. When the trucker moves work into a department, he removes a Completion Notice from the envelope and delivers it to the production clerk who will then know the work is in the department.

Each production clerk is given a punch which symbolizes his or her department, for instance, department A has an "A" punch, etc. After each operation has been performed, the production clerk in that department will punch the Route Card on the left side through that operation symbol number, and then write in the date, his clock number, the number of good pieces, and scrap or repairs if any, in the columns provided for same opposite that operation. At the same time, the production clerk will post the same information on the Completion Notice originally obtained from the trucker and send it direct to the Production Planning Department. The Completion Notice does not have to be punched.

The Route Card will always remain in front of the envelope and be visible, so that the Completion Notices behind it can be pulled out one at a time. Each bin must

have a Route Card and a set of Completion Notices. Therefore, if it is essential to split a part of the work and move it ahead, a new Split Lot Route Card can be obtained by telephoning the Production Planning Department who will deliver it immediately. A sufficient supply of these Split Lot Route Cards is produced at the same time that the original Route Cards are run off on the Mimeograph duplicator. The Production Planning Department will have a master punch, and punch the operations on this Split Lot Route Card which have been performed up to the time of the split. Each department will have only one punch which should be in the possession of the production clerk at all times, so that no one else will be able to use it.

2. Handling Split Lots

Upon receipt of the Split Lot Route Card, the number of pieces split will be posted on the original Route Card in the space provided plus the department from and the department to which the material is moving. The Split Lot Route Card will show the number of pieces accompanying it when received, as the Production Planning Department must have this information in order to issue it. From that point on, the Split Lot Route Card and Completion Notices accompanying it will be used in the same way as regular Route Cards.

The Production Planning Department will have

a Record of Production Progress Card for each Route Card in the shop. When the Production Planning Department receives Completion Notices after each operation has been performed, they will be able to post this information on the Record of Production Progress. This will give valuable information to the Production Planning Department, in that they will know the progress of the work by operations, and be better able to schedule the work as well as meet the customer's required delivery dates. When finished parts are received by the Shipping Department, the good pieces received by them will be posted on the Route Card and after the Heat number is taken from it. The completed Route Card will be sent to the Production Planning Department, thus acting as a notice of parts shipped daily.

It is the constant necessity for splitting lots that makes this particular adaptation of the Route Card so useful. Many things can cause split lots, such as a rush order which has to be put onto a machine which is in the middle of a run; or a breakdown of the machine which necessitates holding up a part of the lot until the machine has been repaired. Whatever the cause, though, this Split Lot Route Card can handle the situation adequately.

3. Coupon Type Production Tickets

Still another type of production ticket which is completely different in its operation is the coupon type Production Ticket (Figure 29). This is used generally on

STYLE	QUANTITY	FINISHED DATE
411-A	300	

INSPECTED BY

GEORGIAN ELECTRIC

IDENTIFICATION

OPER. No.	OPERATION
1	PRIMARY PUNCHING
2	PRIMARY CORE
3	FRAME
4	FOOT
5	FRAME AND CORE
6	LEADS
7	INSULATION MATERIAL
8	WOUND PRIMARY
9	
10	
11	SHAFT
12	ARMATURE PUNCHING
13	
14	
15	COMMUTATOR
16	FAN
17	INSULATION MATERIAL
18	ARMATURE ASSEMBLY
19	
20	
21	FRONT BRACKET
22	REAR BRACKET
23	BALL BEARING FRONT
24	BALL BEARING REAR
25	FRONT BEARING CAP
26	REAR BEARING CAP
27	
28	
29	ROCKER RING COMP.
30	CARBON COMP.
31	SHORT CIRCUITER
32	
33	
34	HARDWARE ITEMS
35	GENERAL ASSEMBLY
36	
37	

OFFICE CONTROL

	1	2	3	4	5	6	7	8	9	10	11
	QUAN.	QUAN.	QUAN.	QUAN.	QUAN.	QUAN.	QUAN.	QUAN.	QUAN.	QUAN.	QUAN.
	300	300	300	300	300	300	300	300	300	300	300
	SETUP	SETUP	SETUP	SETUP	SETUP	SETUP	SETUP	SETUP	SETUP	SETUP	SETUP
	1	2	3	4	5	6	7	8	11	12	15
	PR.	PR.	PR.	PR.	PR.	PR.	PR.	PR.	PR.	PR.	PR.
	45	15	20	32	40	55	75	23	44	48	50
530											

STYLE	QUANTITY	SCHED. DATE
411-A	300	4/7/42

CHECKED BY

FACTORY CONTROL

	12	13	14	15	16	17	18	19	20	21	22
	QUAN.	QUAN.	QUAN.	QUAN.	QUAN.	QUAN.	QUAN.	QUAN.	QUAN.	QUAN.	QUAN.
	300	300	300	300	300	300	300	300	300	300	300
	SETUP	SETUP	SETUP	SETUP	SETUP	SETUP	SETUP	SETUP	SETUP	SETUP	SETUP
	16	17	18	21	24	27	45	25	26	29	35
	PR.	PR.	PR.	PR.	PR.	PR.	PR.	PR.	PR.	PR.	PR.
	71	33	35	42	54	54	54	40	55	75	73
530											

STYLE	QUANTITY	SCHED. DATE
411-A	300	4/7/42

CODE

Figure 29

piece work in such businesses as shoe companies, electrical apparatus companies and brush companies. To explain how the system works, however, a fictitious concern (The Georgian Electric Company) will be used.

In this particular case, they are manufacturing a motor identified on the Production Ticket as Style 411A. This lot will consist of three hundred pieces which have to go through twenty-two operations before they are completed. The ticket itself is a printed form consisting of twenty-six perforated smaller tickets. The production information is mimeographed on this printed form by means of a form-topped 1061k stencil.

In making any motor, certain operations must be performed. So all of the possible operations for any motor are listed in the middle of the Production Ticket with empty spaces left for filling in extra operations for special jobs. When this order for three hundred motors comes to the Planning Department, they make up a pencil copy of the Production Ticket filling in the number of operations to be performed, under the heading "Setup" in the order in which they are to be performed. Each little work ticket also has mimeographed on it, the price to be paid per piece.

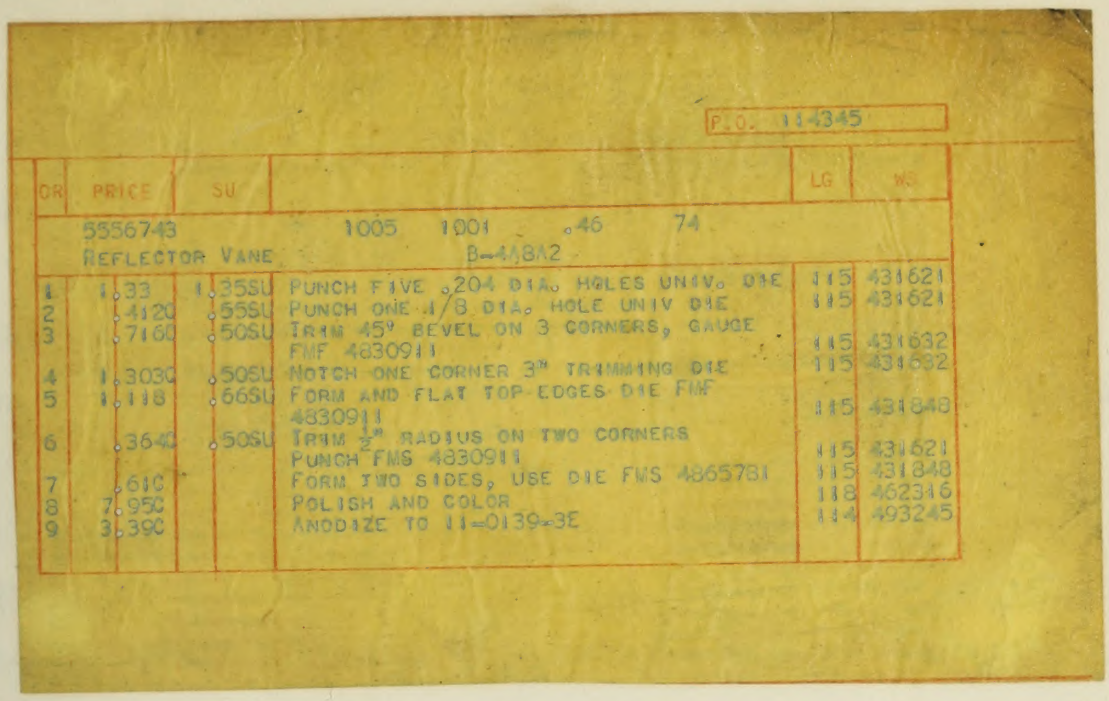
When the job goes into the plant, the Identification tag is attached to the motor at the first work station. The Office Control Tag is placed in the Work-In-Proc-

ess file, and the Factory Control Tag is filed in the Dispatch Cage. When the first operation is completed, the worker removes his individual Production ticket and keeps it until the end of the day when he turns it in with the rest of the tickets he has collected. It is from these tickets that his pay is computed. As the job goes along, each succeeding ticket is removed by the worker performing that operation. So, on this job requiring three hundred motors, three hundred of these Production Tickets will be duplicated on the Mimeograph. This particular piece work system is one of the oldest ones in use and yet it still seems to operate as efficiently as many of the newer systems.

4. The Piecework Voucher System

Another of the newer systems, which again is completely different in operation from any that have been explained so far, is the Piecework Voucher System. Its use at the General Electric Company plants in Lynn, will be the basis for the explanation of it which is to follow.

The basis for this Piecework Voucher system (Figure 30) is a three by five inch printed form on which all of the essential information for the manufacture of any one part is mimeographed. The form has spaces on it for duplicating the purchase order number, the part number, the part name, the operation number, the price to be paid for each operation, the set-up cost for each operation, a de-



P.O. 114345

OR	PRICE	SU		LG	WS
5556743		1005	1001 .46 74		
REFLECTOR VANE			B-4A8A2		
1	1.33	1.35SU	PUNCH FIVE .204 DIA. HOLES UNIV. DIE	115	431621
2	.412C	.55SU	PUNCH ONE 1/8 DIA. HOLE UNIV DIE	115	431621
3	.716C	.50SU	TRIM 45° BEVEL ON 3 CORNERS, GAUGE FMF 4830911	115	431632
4	1.303C	.50SU	NOTCH ONE CORNER 3" TRIMMING DIE	115	431632
5	1.118	.66SU	FORM AND FLAT TOP EDGES DIE FMF 4830911	115	431848
6	.364C	.50SU	TRIM 1/2" RADIUS ON TWO CORNERS PUNCH FMS 4830911	115	431621
7	.61C		FORM TWO SIDES, USE DIE FMS 4865781	115	431848
8	7.95C		POLISH AND COLOR	118	462316
9	3.39C		ANODIZE TO 11-0139-3E	144	493245

PIECES	DATE	PIECEWORK VOUCHER	P. O.	PIECES APPROVED
	PAY NO. NAME		24680	

5556743 L005 1001 .46 74 — REFLECTOR VANE — B-4A8A2

1	1.33	1.35SU	PUNCH FIVE .204 DIA. HOLES UNIV. DIE	115 431621	1111
2	.412C	.55SU	PUNCH ONE 1/8 DIA. HOLE UNIV DIE	115 431621	2222
3	.716C	.50SU	TRIM 45° BEVEL ON 3 CORNERS, GAUGE FMF 4830911	115 431632	3333
4	1.303C	.50SU	NOTCH ONE CORNER 3" TRIMMING DIE	115 431632	4444
5	1.118	.66SU	FORM AND FLAT TOP EDGES DIE FMF 4830911	115 431841	5555
6	.364C	.50SU	TRIM 1/2" RADIUS ON TWO CORNERS PUNCH FMS 4930911	115 431621	6666
7	.61C		FORM TWO SIDES, USE DIE FMS 4865781 FOR ONE SIDE	115 431841	7777
8	7.95C		POLISH AND COLOR	118 462316	8888
9	3.39C		ANDIZE TO 11-083903E	144 493245	9999
					10000

S. U. APPROVE | 1 PAYROLL | AMOUNT

LW-2375 (3 SHTS.) 25M-12-20-44

S. U. APPROVE | 2 DISTRIBUTION | AMOUNT

LW-2375 (3 SHTS.) 25M-12-20-44

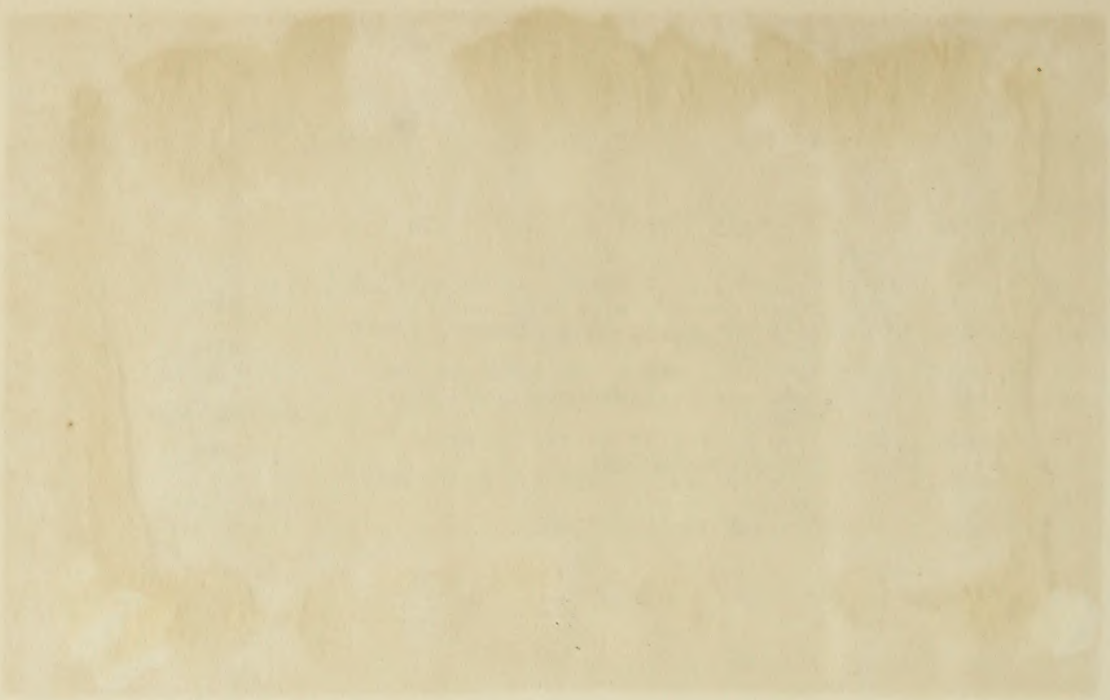
S. U. APPROVED | 3 RECEIPT | AMOUNT

LW-2375 (3 SHTS.) 150M-4-2-46

PIECES APPROVED
1111
2222
3333
4444
5555
6666
7777
8888
9999
10000

PIECES APPROVED
1111
2222
3333
4444
5555
6666
7777
8888
9999
10000

Figure 30



scription of each operation to be performed, the building where the work is to be done and the work station number.

In order to get all of this information on the three by five forms, a fourteen pitch typewriter is used.[1] It has been found that the most economical stencil to use for the job is a 1093k stencil with eight copies of the form, form-topped on it in two columns of four each. When this stencil has finally been typed and cut into its eight component pieces, each one will be 5-5/8 inches by 3-1/2 inches. This size is such that it would not be possible to get two of them from either a 1089k or a 1090k stencil; and so it is more economical to cut them from the large 1093k stencil. In cases like this, it is always wise to experiment carefully to find the best way to utilize as much of a stencil sheet as possible.

The Planning Department makes up the original pencil copy of the Piecework Voucher, and sends it to the Mimeograph Department where the stencils are typed and the copies run off. Before the 1093k stencil is typed, it is cut in half from top to bottom leaving four of the Voucher forms, form-topped on each half. Four jobs are then typed up on each half stencil, cut into their component pieces and

1. A pica type typewriter has ten characters to the inch. An elite type typewriter has twelve characters to the inch, and a fourteen pitch typewriter has fourteen characters to the inch.

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delivered to the Mimeograph operator for duplication. The operator places each small stencil over a cut out window on the Mimeograph cylinder and runs off the requisite number of copies.

5. The Voucher Ticket

For each operation listed on the Voucher, a set of three tickets must be duplicated. They are numbered 1,2,3 and are headed respectively Payroll, Distribution, and Receipt. The backs of the first two copies have one half inch carbon strips painted along their top and bottom edges for triplicating additional information just before the job goes into production, and after each operation is completed. Along the top strip there are places for writing in the date and printing the worker's name and payroll number from an Addressograph plate in the dispatcher's cage when the job actually goes into production. There is also space for writing the number of pieces the worker is given to work on. Along the bottom edge there are spaces for two pencil notations, one for the foreman's initials approving the set-up of the job, and the other for the amount the worker is to be paid for the job.

Along the right hand edge of the Voucher are printed four columns of consecutive numbers from one to ten. These are used by the Foreman, when the work is done, for punching the number of Pieces Approved.

It will be seen that all three of the forms

delivered to the Mimeograph operator for duplication. The operator places each small stencil over a cut out window on the Mimeograph cylinder and runs off the requisite number of copies.

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Along the right hand edge of the Voucher are printed four columns of consecutive numbers from one to ten. These are used by the foreman, when the work is done, for punching the number of Pieces Approved.

It will be seen that all three of the forms

are identical then with the exceptions of the headings and their respective numbers. After they are printed, they are assembled in reverse order and packaged in reams. That is to say, the top sheet in the package is number 3, the next is number 2, and the next is number 1 and so on in similar sets. This is done so that after they have been run through the Mimeograph duplicator, they will lay in the receiving tray in their normal 1,2,3 order.

If there are nine operations listed on the Voucher, then there must be twenty-seven copies of it duplicated. Each set of three is stapled together and held in file until the job goes into operation.[1] Next, the Dispatch Order (Figure 31) is duplicated. This is a printed form with spaces on the back for recording the progress on each operation of the job as it proceeds through the plant. This is filed and posted too, in the dispatch cage. Next, an Identification Tag (Figure 32) is duplicated for each tote box needed to handle the order. Since the information is not needed on these tags, all of the pricing information is blacked out on the card itself.

Next, there is an operation completion notice (Figure 32) for each operation. This is duplicated on a blank,

1. The paper work in production control is always done several days before the job is released by the dispatcher for actual production.

PIECES	SCHEDULE	DISPATCH ORDER	P.O.
		LW-2375-A (12-44)	

DATE RECEIVED	DISPATCH RECORD	COMPLETED

REMARKS	INSPECTION RECORD				
	QUANTITY		OPER. NO.	APPROVED	
	GOOD	REJ.		QUAN.	QUAL.

Figure 31

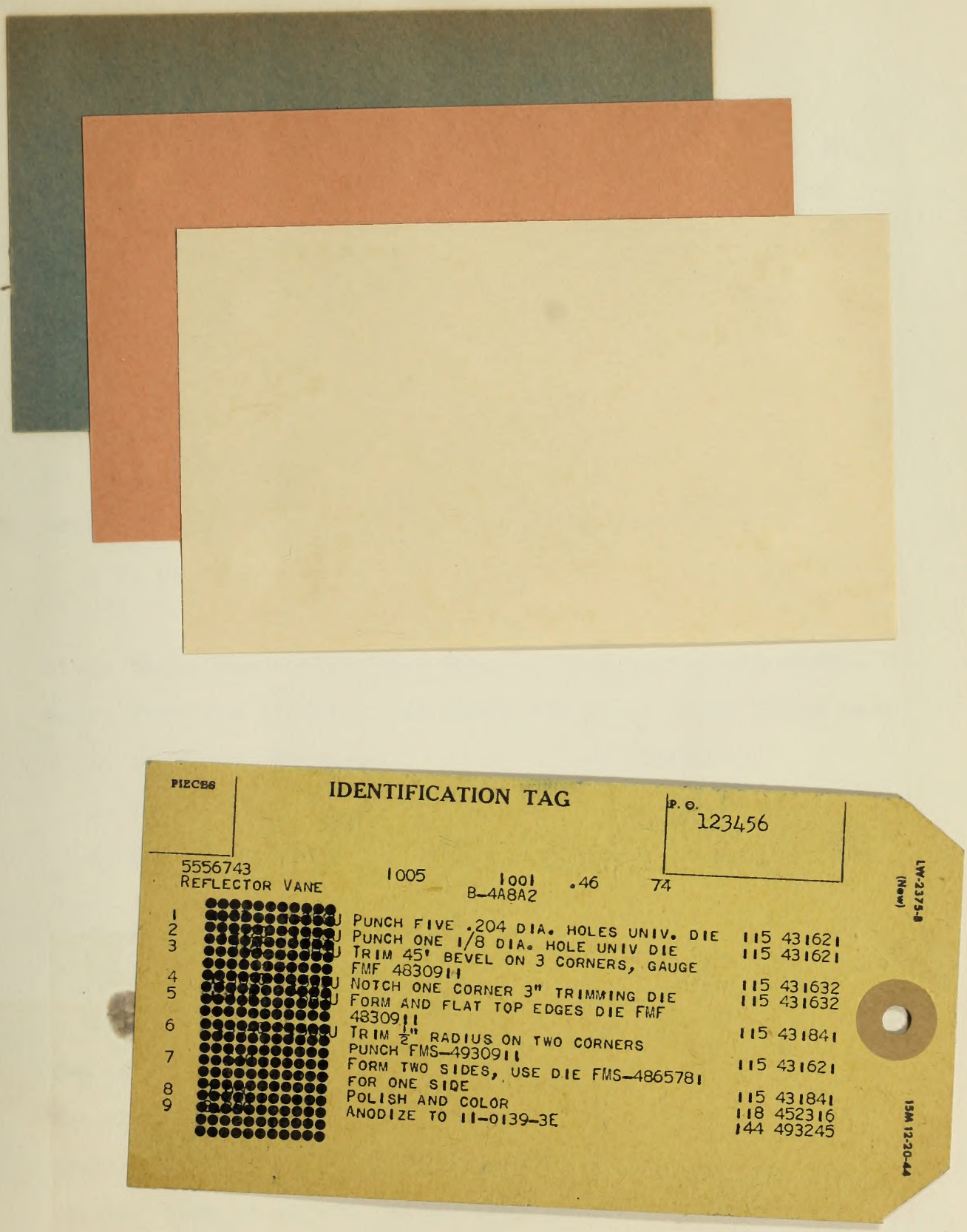

PIECES
IDENTIFICATION TAG
P. O.
123456
5556743
REFLECTOR VANE
1005
1001
B-4A8A2
.46
74
1
2
3
4
5
6
7
8
9
PUNCH FIVE .204 DIA. HOLES UNIV. DIE
PUNCH ONE 1/8 DIA. HOLE UNIV DIE
TRIM 45° BEVEL ON 3 CORNERS, GAUGE FMF 4830911
NOTCH ONE CORNER 3" TRIMMING DIE
FORM AND FLAT TOP EDGES DIE FMF 4830911
TRIM 1/2" RADIUS ON TWO CORNERS
PUNCH FMS-4930911
FORM TWO SIDES, USE DIE FMS-4865781 FOR ONE SIDE
POLISH AND COLOR
ANODIZE TO 11-0139-3E
115 431621
115 431621
115 431632
115 431632
115 431841
115 431621
115 431841
118 452316
144 493245
LW-2375-B (New)
15M 12-20-44

Figure 32

blue, three by five card. One of these, of course, is returned to the Scheduling Department at the completion of each operation. Next, an orange card is duplicated. This is filed in the Dead Load file in the Planning Department until the job goes into operation, when it is moved to the Work-In-Process file. And lastly, there is a Notice-to-Other-Buildings. One copy (on a white card) of this is sent to the Superintendent in each building where work on this order is to be performed.

6. Copy Requirements

In the case being used for this particular study then, there will be a total of 115 copies all duplicated from one writing. In recapitulation, these forms are:

1. Piecework Voucher	27	copies
2. Identification Tags	74	"
3. Operation Completion Notices	9	"
4. Notice to Other Buildings	3	"
5. Dead Load File	1	"
6. Dispatch Order	1	"

The copies are all run off on the Mimeograph duplicator in the order shown. The Voucher forms are set up first in a special feed table designed specifically to handle that particular size of paper. After they have been fed automatically through the machine, the Identification Tags are placed on the feed table and run through. When this biggest

time, three by five card. One of these, of course, is returned to the Scheduling Department at the completion of each operation. Next, an orange card is duplicated. This is filed in the Dead Load File in the Planning Department until the job goes into operation, when it is moved to the Work-In-Process file. And lastly, there is a Notice-to-Other-Buildings. One copy (on a white card) of this is sent to the Superintendent in each building where work on this order is to be performed.

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biggest part of the job has been completed with the automatic feed, the rest of the copies are run through by hand. Altogether, it takes less than two minutes to run the whole job.

In the operation of this Voucher system, each worker is given a set of vouchers before he begins work on any one operation. His name and payroll number are printed at the top of the form from an Addressograph plate. The date is written in, and the number of the operation he is to perform is punched at the left hand edge of the card. All of this is done by the Dispatcher at the Dispatch cage.

At the Work Station where the job is to be done, the Foreman writes in the number of pieces the man has to work on and signs his initials if he approves the machine set-up. When the man has completed the operation, or at the end of the day, the Foreman punches the number of pieces approved on the right hand end of the vouchers. The three copies of the Voucher are then separated. Copy number one goes to the Payroll Department where the man's weekly pay is figured. Copy number two goes to the Planning Department for computing future piecework rates. Copy number three is retained by the worker as his receipt for work done.

Chapter XII

Further Variations

1. The Submarine Signal Company

A variation on the Bill of Materials as it is used by the Submarine Signal Company of Boston, Massachesetts, is interesting in that it ties together two forms which were originally devised and used by two widely separated departments in the company. The Cost Department used one form to collect their cost data on all assembly work, and the Kit Control Department used another form, embodying practically the same information, in making up their sub-assembly parts lists. So both departments got together and worked out a combined form now known as the Material Charge Requisition (Figure 33).

2. The Material Charge Requisition

This form as it was finally evolved was die-impressed onto a 1061k stencil. Before explaining the form and all its functions, though, perhaps there should be some explanation of one recurring term in it which is a bit obscure. The term is "Kit". At the Submarine Signal Company a Kit is a sub-assembly. In manufacturing their products a great many sub-assemblies are necessary before final assemblies are completed. Also, some of the sub-assemblies require much more skilled labor than others. So they collect all the materials for each sub-assembly into baskets or kits in the Stores Department. These are given out to the work-

FORM 111A

MATERIAL CHARGE REQUISITION

SHOP ORDER NO. | Date Issued | Date Completed | Kit No. | Set or Unit No. | To Set or Unit No.

Total No. of Sets or Units on this Requisition | Assembly No. | Alt. No. | Descrip. | Model TYPE

Author | Date Originated | Job No. | Project No. or Contract No. | Sheet No. | of

DESCRIPTION OR NAME OF ITEM	PART NUMBER	Quantity Per Kit	Quantity Requested	Quantity Short	Quantity Delivered	UNIT PRICE	VALUE

SERIAL NO. K

Person Requesting Material | Person Filling Requisition

Person Receiving Material | Deliver Completed Kit To | For Kit No. | Total Value $

Figure 53

ers according to their skills and returned again to Stores when they have been completed so that they can again be made up into other kits until the final assemblies are completed.

This form then is a Bill of Material made up in the Kit Control Department for the assembly of each Kit before it is given out to be assembled. Along the top of the form there are spaces on the top line for the Shop Order number, the date issued, the date completed, the Kit number, the Set or Unit number (of which this Kit will become a part) and the Set or Unit number of which that Set or Unit will become a part. On the second line there is space for noting the "Total Number of Sets or Units on This Requisition", the Assembly number, any alteration numbers, a description of alterations and the model type. And on the third line there is space for the author's signature, the date originated, the job number, the project number or contract number, and the sheet number.

In the body of the form there are columns for "Description or Name of Item", Part Number, Quantity per Kit, Quantity Requested, Quantity Short, Quantity Delivered, Unit Price, and Value. While along the bottom of the form, there are spaces for the person requesting material, the person filling the requisition, and the person receiving the material to sign his name, the place where the completed Kit is to be delivered, the next Kit number, and the total value of the parts in the Kit.

are according to their skills and returned again to stores
when they have been completed so that they can again be made
up into other kits until the final assemblies are completed.

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in the Kit Control Department for the assembly of each kit
before it is given out to be assembled. Along the top of
the form there are spaces on the top line for the Shop Or-
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number, the Set or Unit number (of which this Kit will be-
come a part) and the Set or Unit number of which that Set or
Unit will become a part. On the second line there is space
for noting the "Total Number of Sets or Units on This Requis-
ition", the assembly number, any alteration numbers, a de-
scription of alterations and the model type. And on the
third line there is space for the author's signature, the
date original, the job number, the project number or con-
tract number, and the sheet number.

In the body of the form there are columns
for "Description or Name of Item", Part Number, Quantity per
Kit, Quantity Required, Quantity Short, Quantity Delivered,
Unit Price, and Value. While along the bottom of the form,
there are spaces for the person requesting material, the
person filling the requisition, and the person receiving the
material to sign his name, the place where the completed
kit is to be delivered, the next Kit number, and the total
value of the parts in the kit.

After a pencil copy of the form has been made up, it is typed onto a stencil and nine copies are run off on the Mimeograph duplicator. They are then distributed as follows. The author of the form gets one copy for his personal file. The Stores Department gets four copies. Of these, one is filed. Two are sent out with the Kit, one of which stays with the Kit until it is returned to the Stores department, and the other is signed by the person receiving the Kit and returned to the Stores department as a receipt. The fourth copy is used by the Procurement division for obtaining items which are shown to be short on the form. For, due to shortages these days, the quantity requested is often less than the quantity delivered by the Stores department.

The Accounting department gets two copies. They file one and use the other as a working copy in figuring their costs. And the Kit Control Group gets two copies. They also file one and use the other as a working copy in making up another Material Charge Requisition for the next Kit.

When a company's product is such that they can use a flow type of production where the raw material leaves the Stores department and goes right on through all its phases of manufacture until it reaches the Shipping department, this rather intricate sort of control is not necessary. But where each order differs so from the last one, and where the manufacturing lots are relatively small, this

is a very efficient way of handling the problem. It gives the Stores department a chance to apportion the work in accordance with its complexity.

3. The Easy Washing Machine Company

Another adjunct to good systems is the Engineering Change Notice. A good example of this is shown in the Easy Washing Machine Company case. Their Engineering Change order (Figure 34) master is made up on a 1061k die-impressed stencil.

The Drawing Change Request can originate in any department, but it has to have the approval of the Production Engineering department, the Production Control department and the Manufacturing and Inspection departments before it is sent to the Chief Draftsman for execution. The Chief Draftsman assigns a Request Number to it and has the original tracing altered. When the tracing is ready, it is sent with the Drawing Change Request to the Specification Engineer. The Specification Engineer writes a pencil copy of the Engineering Change order, and sends it to the typist.

4. The Engineering Change Order

The typist types the die-impressed Change order stencil, which contains the usual requisite information such as the issue date, the latest drawing date and the drawing number. There is a space for the person who requested the change to sign his name and the date, and there is room for the requisition number, the drawing title, the na-

ISSUE DATE

EASY WASHING MACHINE CORP.
DRAWING RELEASE - CHANGE ORDER

LATEST DWG. DATE

DRAWING NO.

CHANGE REQ. BY

DATE

REQ. NO.

DRAWING TITLE

CHANGE LETTER NO.

NATURE OF CHANGE

FROM

TO

REASON FOR CHANGE

DISPOSITION OF PARTS

WHEN EFFECTIVE

B/MS Effected

Other Dwgs.

AUTHORIZED BY_____ ENGINEER

APPROVED BY_____ CHIEF DRAFTSMAN

THE UNDERSIGNED HEREBY ACKNOWLEDGE NOTIFICATION OF ABOVE CHANGE AND RECEIPT OF REVISED BLUEPRINT

DEPT.	NO.	SIGNATURE	DATE	DEPT.	NO.	SIGNATURE	DATE	DEPT.	NO.	SIGNATURE	DATE

Figure 34

ture of the change, the reason for the change, the disposition of parts and the date when the change is to take effect. The stencil and the pencil copy are then returned to the Specification Engineer.

The Specification Engineer proofreads the stencil, and sends it with the Drawing Change Request and the Altered Tracing to the Chief Draftsman. He signs the stencil as his approval. The Drawing Change Request is then sent to file. The altered tracing is sent to the Blueprint Production Department where the backing sheet is removed from the stencil and held in temporary file and the stencil is sent to the Mimeograph duplicator. Meanwhile,the required number of blueprints are made and sent to the Chief Draftsman, and the tracing is sent to file.

The required number of copies of the Engineering Change order are duplicated and sent to the Chief Draftsman. A new blueprint and a copy of the Engineering Change order are distributed to the using departments. Each department signs the backing sheet as a receipt that they have received the new blueprint and the Change Order. The backing sheet is then sent to file as a permanent record that the change has been made and the copies distributed.

This system does provide an efficient way of notifying all interested departments of the forthcoming engineering changes and yet it also shows how difficult of achievement is the ideal single writing system. For in this

ture of the change, the reason for the change, the disposal-
tion of parts and the date when the change is to take effect.
The stencil and the pencil copy are then returned to the
Specification Engineer.

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backing sheet is then sent to file as a permanent record
that the change has been made and the copies distributed.

This system does provide an efficient way of
notifying all interested departments of the forthcoming
engineering changes and yet it also shows how difficult of
achievement is the ideal single writing system. For in this

system there are seven different forms used of which only three are produced in a single writing. All the forms used are:

1. Drawing Change Request
2. Altered Tracing
3. Pencil Copy of Engineering Change Order
4. 1061k Die-impressed Stencil
5. Backing Sheet of the 1061k Stencil
6. New Blueprints
7. Duplicated Copies of the Engineering Change Order.

Some further reduction in the number of these forms is possible where the drawing or altered drawing is small enough to fit on a stencil. Where this is possible, the job can be very neatly done by having the rest of the stencil die-impressed and the section, where the drawing is to be made, form-topped in small squares for a guide in drawing the alterations.

5. The Hold-Up Notice

Engineering change orders seem, in spite of their apparent simplicity, to be as varied as shop orders themselves. The Hold-up Notice (Figure 35) is a case in point. The Hold-up Notice, duplicated from a die-impressed stencil, is distributed to all interested departments before the Engineering Change order is made up. As soon as it becomes apparent that a change must be made in some part or process, the Hold-up Notice is sent out. This form gives

PART OR ASSMB. NO. _____

HOLD-UP NOTICE

HOLD-UP No. 3013

PART NAME _____ DATE _____

MODEL OR ASSMB. NO. _____

COPIES TO:

THIS IS YOUR AUTHORITY TO STOP ALL WORK IN CONNECTION WITH THE ABOVE NAMED PART UNTIL FORMAL HOLD-UP RELEASE NOTICE IS ISSUED.

HOLD-UP POINT _____

REASON FOR HOLD-UP _____

INSTRUCTIONS _____

APPROVED BY _____ CHIEF ENGINEER

RELEASED BY _____ PLANNING DEPT.

PART OR ASSMB. NO. _____

HOLD UP RELEASE NOTICE

HOLD-UP RELEASE No. 6027

PART NAME _____ DATE _____

MODEL OR ASSMB. NO. _____

COPIES TO:

THIS RELEASE HAS BEEN ISSUED TO COVER CANCELLATION OF HOLD-UP NOTICE NO. _____ DATED _____ ON THE ABOVE NAMED PART.

WORK TO BE RESUMED ☐ WITHOUT CHANGE. ☐ WITH CHANGE AS NOTED ON CHANGE ORDER NO. _____

INSTRUCTIONS _____

APPROVED BY _____ CHIEF ENGINEER

RELEASED BY _____ DEPT.

Figure 35

the part or assembly number, the part name and date, the point where the work is to be held up, the reason for the hold up, any instructions and the following statement. "This is your authority to stop all work in connection with the above named part until formal Hold-up Release Notice is issued".

Then, having issued this notice, the Engineering department makes up and distributes the Change Order. If, for some reason, it is decided not to make a change after all, the Change Order is, of course, not made up; but in either case, the work is not resumed again on that part until the Hold-up Release Notice is issued. This is another die-impressed form which gives the date, the part or assembly number, the part name, any instructions, and this statement. "This release has been issued to cover cancellation of Hold-up Notice No.-----dated----- on the above named part. Work to be resumed ☐ without change, ☐ with change as noted on change order No.-----." This may seem a trifle involved, and yet where the scope of operations is big enough, it is an important part of any Engineering Change order system.

6. Labels

Of course, getting work out of the plant in an efficient manner is just as important as getting the work through it. After the product has been crated or boxed, it must be identified somehow and addressed to the customer. This job can be handled very nicely with a label (Figure 36).

the part or assembly number, the part name and date, the point where the work is to be held up, the reason for the hold up, any instructions and the following statement. "This is your authority to stop all work in connection with the above named part until Formal Hold-up Release Notice is issued".

Then, having issued this notice, the Engineering department makes up and distributes the Change Order. If, for some reason, it is decided not to make a change after all, the Change Order is, of course, not made up; but in either case, the work is not resumed again on that part until the Hold-up Release Notice is issued. This is another die-impressed form which gives the date, the part or assembly number, the part name, any instructions, and this statement. "This release has been issued to cover cancellation of Hold-up Notice No.------dated------ on the above named part. Work to be resumed ☐ without change, ☐ with change as noted on Change Order No.------." This may seem a trifle involved, and yet where the scope of operations is big enough, it is an important part of any Engineering Change Order system.

6. Labels

Of course, getting work out of the plant in an efficient manner is just as important as getting the work through it. After the product has been created or boxed, it must be identified somehow and addressed to the customer. This job can be handled very nicely with a label (Figure 66).

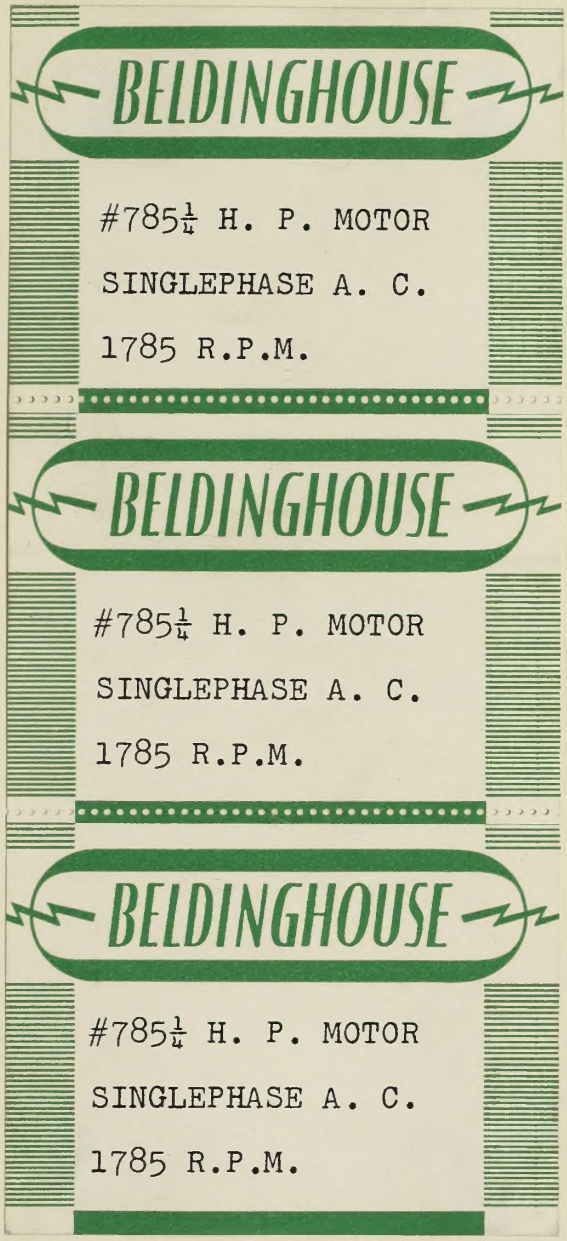

BELDINGHOUSE
#785¼ H. P. MOTOR
SINGLEPHASE A. C.
1785 R.P.M.
BELDINGHOUSE
#785¼ H. P. MOTOR
SINGLEPHASE A. C.
1785 R.P.M.
BELDINGHOUSE
#785¼ H. P. MOTOR
SINGLEPHASE A. C.
1785 R.P.M.

Figure 36

Usually, a 1089k or 1090k stencil is used with one or two facsimiles of the label form-topped on the top of the stencil as a guide for the typist. However, the registration tolerances are often so generous that the form-topping is not necessary in order to get all of the required information into the space allowed.

It is necessary though, to use hard-set ink in duplicating the labels. For there is no telling how long a package may have to stand out in the weather, and the copy must not fade out in the sun or wash off in the rain.

7. Packing Lists

Another part of the shipping job is the packing list (Figure 37). This would ordinarily be a simple job except for the fact that orders are all too often behind schedule by the time they reach the Shipping Department. And when the Packing List runs to several pages, delays can be costly. The Submarine Signal Company of Boston, Massachusetts, has its Packing Lists die-impressed on 1060k stencils. The standard part of each order is duplicated in advance, leaving only a single page to be typed and run off when the job is finally delivered to the Shipping department. This page consists of the items which must differ (according to the customer's specifications) on each product in the shipment.

FORM 116

Package No. 231

Customer's Order No. 1863

Shipping Order No. 938

Adm. Order No. 535

Part Shipment X

Full Shipment

Final Shipment

PACKERS LIST

FROM

SUBMARINE SIGNAL COMPANY

247 ATLANTIC AVENUE
BOSTON, MASS., U. S. A.

Shipped to Electric Boat Co. Date 1-26-44

New London, Conn.

Via New York, New Haven & Hartford Charges none

QUAN.	PART NO.	DESCRIPTION	UNIT PRICE	TOTAL
1	#3144	Hand operated variable speed indicator. This is a fictitious sample copy #2583 Segment fitted holders for use with electric engines.		
2	#2327	Semi automatic listening devices #2643 Handle for model #2583 indicator.		
4	#9418	This is a fictitious sample. Number #9234 Screen Grid.		
1	#A-7	Condenser #2848 Radio tubes for pronged sockets.		
3	#333	Sample copies as per instructions in #2848 catalogues.		
1	#333	Descriptive material showing how to get the best results from this preduplicated packing list with savings up to 75% in typing time.		

Gross Weight 1,000

Net " 950

Dimensions 1 x 1 x 10

Shipper J.J.F.

Figure 37

Chapter XIII

Conclusions

1. Possible Improvements

It has not been the writer's intention to infer in the foregoing discussion that the Mimeograph is a panacea for all production control problems. The Mimeograph process has several limitations which still need to be worked out.

There are many applications, for instance, which could be handled by the Mimeograph process with an even faster drying ink. As it is now, most any job which requires printing on both sides of the paper, must be slip-sheeted,[1] and in many cases, this becomes completely impractical due to the extra operations it entails and the consequent time it consumes. Although the present Hard-set ink dries within about eight minutes, it would take an ink capable of drying instantly on contact with the paper to satisfy the requirements of these particular jobs.

As for the stencils, their uses could be increased immeasurably if they were developed further in two different directions. First, they are too expensive at present, for many short run jobs and second, they are not durable or flexible enough for many long run applications. The Hood

1. See Chapter II on the use of the Interlayer for slip-sheeting.

Rubber Company, as an example, has an excellent application for a stencil which is strong and flexible enough to withstand the wear of being put on the Mimeograph fifty times. Each time before being put on the machine, the stencil might require from one to six corrections with as many corrections, over the life of the stencil, as four in any one spot. One hundred copies would be needed on every run, and the stencil would have to be put through a stencil cleaning machine each time it was removed from the cylinder before being filed away again. That is a lot to ask of a piece of paper, and yet the present stencil is not far from fulfilling all of these requirements.

Among the various changes, which would improve the efficiency of the machines as production control tools, would be a redesigning of them so as to make it possible to operate them efficiently from a sitting postition. As it is, their operation on big jobs require men simply because they must be operated from a standing position, and the work becomes too tiring for women. According to Barnes,[1] machines of this type should be so designed that they can be operated from a standing or sitting position. This gives the operator a chance to alternate between the two positions and so lessens the fatigue factor of the work. There should be room under

1. Ralph M.Barnes- "Motion and Time Studies".

the machine for the operator's legs and a foot rest for her feet.

Other improvements might include pedal operation of the starting switch, which would facilitate hand slip-sheeting, and a cylinder on which variable strips could be clamped in any position. At the present time all of these improvements, with the possible exception of that of the ink, are quite possible, and will probable be presented to the public before very long.[1]

2. Future Possibilities

When these improvements have been brought about, it should then be possible to go even further into the applications which ever expanding problems of production control have to offer. It should be possible to produce not only Gantt chart forms, but also to correct and extend them as the work on which they are being used, progresses.

It may be possible even to handle applications such as "coverage cards" which are now being done more efficiently on off-set lithograph machines. These applications require not only a block out of certain information, but also the insertion of different information in the space which has been blocked out. On the other hand though, it is just this sort of job that the off-set machines can handle well, and

1. The A.B.Dick Company maintains a research department which is constantly working on these problems.

the chances are, the companies producing each of these two different types of equipment will continue in the future, as they have in the past, to develop intensively, the applications in their own fields, rather than to broaden out into the fields which the other has already cultivated.

Appendix A

Appendix A

MIMEOGRAPH

eograph is a trade-mark of A. B. Dick Company. It stands for unequaled stencil-duplicating results, ured by over sixty years of leadership and a nation-wide organization trained to serve users.



O" IS THE MIMEOGRAPH DUPLICATOR FOR SHORT RUNS . . . HAND

ERATED . . . EASY TO USE FOR COUNTLESS DUPLICATING NEEDS

. INEXPENSIVE . . . IT IS BUILT FOR LONG, DEPENDABLE SERVICE

DUPLICATOR

licator, in this instance, means Mimeograph stencil duplicator—the easiest, fastest, most economical ans of reproducing a few or a few thousand forms, bulletins, letters, etc., in the privacy of your office.

A·B·DICK COMPANY·CHICAGO 6

Branches and distributors in principal cities

946, A. B. Dick Company

Mimeograph 90 duplicator

This stencil duplicator is easy to use and highly satisfactory for all types of office duplicating. It is especially suitable for short runs.

The built-to-last, moderately priced, manually operated stencil duplicator

Easy to operate

The cylinder is easily revolved and each turn of the crank duplicates one copy.

Automatic paper feed

A single sheet is moved into position at each revolution of the cylinder.

Ink-distributing devi

The ink brush is positioned against inside of the open cylinder so that may be distributed with ease.

Paper or card stocks

Various weights, postcard to legal s

Accurate registration **Automatic feed**



Mimeograph brand supplies are manufactu

automatically. The feed table holds sheets of substance 20 paper.

Good registration

urate positioning of copy on each et. Important for forms to be filled- nd for multiple-color work.

Paper stacks smoothly

Efficient stripping and delivery system stacks copies neatly in receiving tray.

Color inks

A pleasing variety of color inks available. Several may be duplicated at one time.

Impression roller action

The roller rises against the cylinder only if paper is in position to receive copy.

Easy adjustment

The position of the copy on the paper may be changed easily and quickly.

Long-life cylinder

Corrosion-resistant, easy to clean. Sturdy diaphragm resists denting; means more good copies.

Dark, durable finish

It has a rich, deep brown color which harmonizes with all types of office furniture and equipment. Pleasing, modern design.



Open-type cylinder

This monogram is a buying guide for long range economy through purchase of top-quality stencil-duplicating products. It is a trade-mark of A. B. Dick Company.

AB

nly by A. B. Dick Company, Chicago 6, Illinois

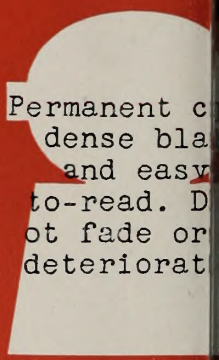
The Mimeograph duplicator is the all-purpose office duplicator

High-quality copies at low-cost-per-copy



Easy to operate . . . *Even school children can operate this equipment after a minimum of instruction. Free instruction is provided by all A. B. Dick Company branches and distributors.*

Permanent, easy-to-read dense black copies . . . *No matter how few or how many copies are produced from one stencil, each copy is equal in legibility to the preceding copy. Mimeograph inks do not fade or deteriorate even under adverse handling conditions. They can be stored for long periods of time without deterioration.*

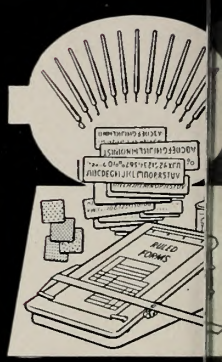


Many types and sizes of Mimeograph brand stencil sheets

From size 4 x 8½-inch to size 8½ x 18-inch . . . For easy stencilization by typewriter, by handwriting, by tracing for illustrations and forms, by electric tabulating equipment and by metal addressing plates. All Mimeograph brand stencil sheets are high quality. They are easy to use, clean and satisfactory for long or short runs. All Mimeograph brand stencil sheets may be filed and rerun.



Complete line of Mimeograph accessories . . . *Color inks . . . styli for tracing illustrations, for drawing forms, and for writing signatures . . . screen plates for tints and shading . . . lettering guides . . . and the Mimeoscope (the Mimeograph illuminated drawing board).*



A B DICK COMPANY

80 Federal Street, Telephone Hubbard 8270

Boston 10, Massachusetts

Form 1 3477—1-46—Printed in U.S.A.

MIMEOGRAPH

Mimeograph is a trade-mark of A. B. Dick Company. It stands for unequaled stencil-duplicating results, assured by over sixty years of leadership and a nation-wide organization trained to serve users.



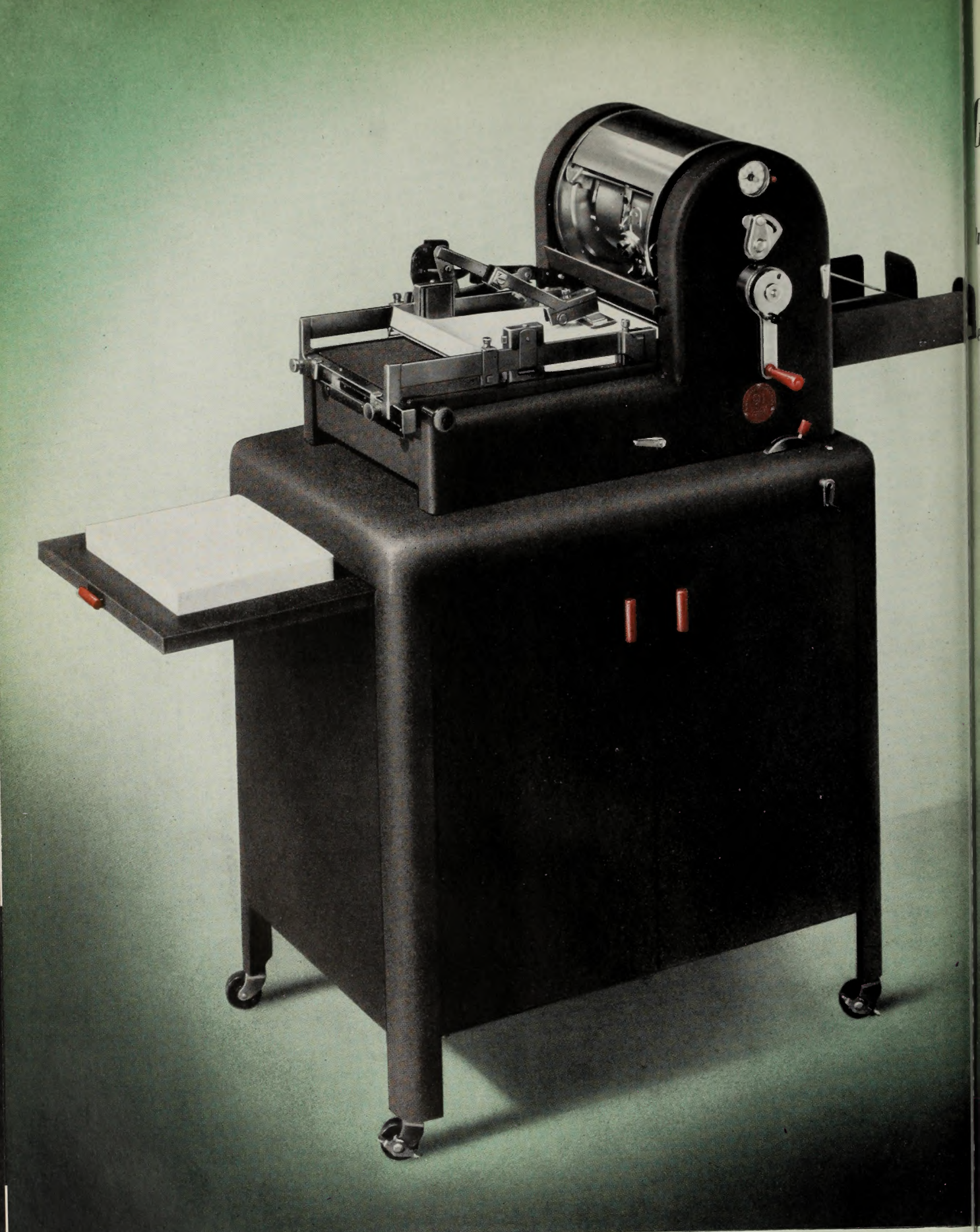
DUPLICATOR

Duplicator, in this instance, means Mimeograph stencil duplicator—the easiest, fastest, most economical means of reproducing a few or a few thousand forms, bulletins, letters, etc., in the privacy of your office.

A·B·DICK COMPANY·CHICAGO 6

Branches and distributors in principal cities

Copyright 1946, A. B. Dick Company



Mimeograph* 91 *duplicator on Mimeograph 16 stand

Mimeograph 91 duplicator

General-purpose, medium-price Mimeograph duplicator—easy to use for a wide variety of clear, legible, black or color copies—electric drive is optional

Accurate Registration A

No variation from the desired position of the copy on the impression paper—important for filling-in forms and for multiple-color work.

Automatic Ink Distribution B

Closed cylinder contains ink reservoir which holds a supply of ink sufficient for thousands of copies. The turn of a lever redistributes the ink.

Recorder C

Counts the duplicated copies and automatically rings a warning bell when set amount has been duplicated. Has simple "on and off" adjustment for running test copies.

Automatic Paper Feed D

The feed table holds 165 sheets of substance 20 paper at one time. On runs in excess of 165 copies feed table automatically drops to reloading position. Right-hand rail pivoted at front end for quick and easy loading of paper. Single sheets are fed at the rate of 50 to 150 sheets per minute.



Flexible Positioning of Copy

The position of the copy on the impression paper may be changed up or down or sideways by simple adjustment of scale-marked controls.

Many Sizes and Weights of Paper

from substance 16 to card stock, in sizes ranging from 3x5 inches to 8½x16 inches.

Color Inks

A pleasing variety of color inks is available. Several colors may be duplicated at one time.

Simple Operation

Main operating controls, accented in red, respond instantly to the operator's touch. A minimum of operating instruction is needed.

Added Features

Ink and oil resistant impression roller rises only when paper is in position to receive copy . . . efficient safety crank and brake . . . central oiling system for main bearings . . . easily removable cylinder.

Mimeograph is a trade-mark of A. B. Dick Company registered in the U. S. Patent Office

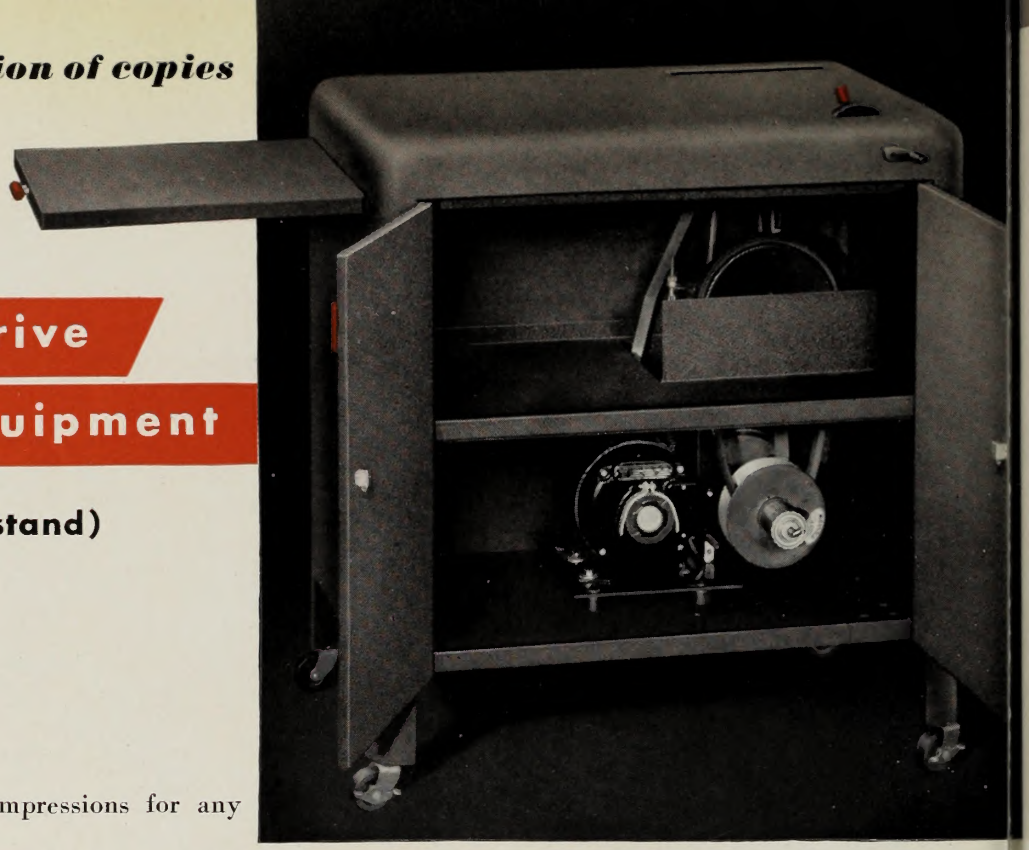
See electric-drive equipment on back page ➡

For easy, fast production of copies

use the

Mimeograph Electric Drive Equipment

(Mimeograph 16 stand)



The Mimeograph 16 stand

Speed control and uniform impressions for any number of copies per minute from 50 to 150 . . . quiet . . . free wheeling . . . safety control prevents starting electric drive while crank is engaged; also prevents engaging cra with drive in operation . . . dependable motor. The stand is all-welded, pressed-steel construction . . . durable da brown finish . . . substantial roller casters, two of which lock . . . one adjustable leg prevents rocking . . . rigid, reinforce insulated doors . . . ample storage space with shelf . . . extension leaf. In ordering specify Mimeograph 16 stand a A.C. or D.C. motor.

A. B. Dick Company
80 Federal Street, Telephone Hubbard 8270
Boston 10, Massachusetts

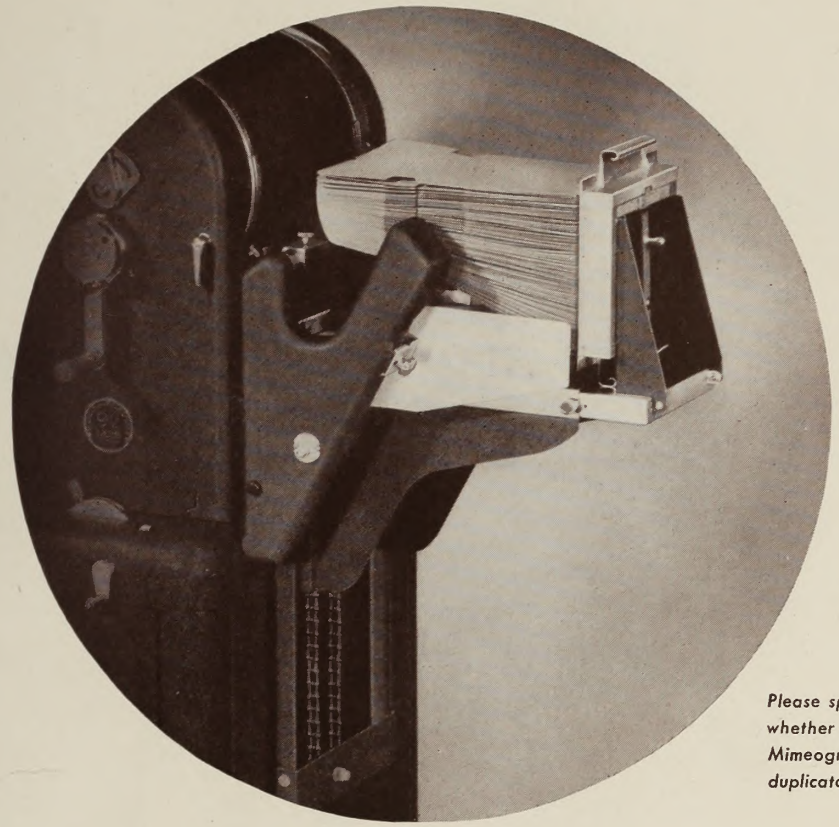
Mimeograph brand products are manufactured only by

A · B · DICK COMPANY

General Offices 720 West Jackson Boulevard, Chicago 6, Illinois

Form 1.3494—6-46—Printed in U.S.A.

Mimeograph* Interlayer* Model 1



Please specify whether for use with Mimeograph 92 or 91 duplicator

Easily installed on Mimeograph* 92 and 91 duplicators without alteration of parts. In position it becomes integral with the duplicator mechanism. Variable high speed (50 to 100 copies per minute). Eliminates offset and smearing of copies. Control coordinated with that of duplicator; both devices stop feeding when supply of either Intertray sheets or impression paper is exhausted or automatic feed is shut off. Mimeograph Interlayer has capacity to interlay 100 copies without stopping. Mimeograph Intertrays can be easily positioned and copies quickly withdrawn. The mechanical forwarding delivery system and lowering tray assure uniform position of copies. After installation, improves efficiency of duplicator in ordinary operation (without interlaying) by increasing receiving-tray capacity to 1000 sheets of substance 20 paper. Provides means for uniformly stacking paper in the tray.

A. B. DICK COMPANY, GENERAL OFFICES, CHICAGO 6, ILLINOIS

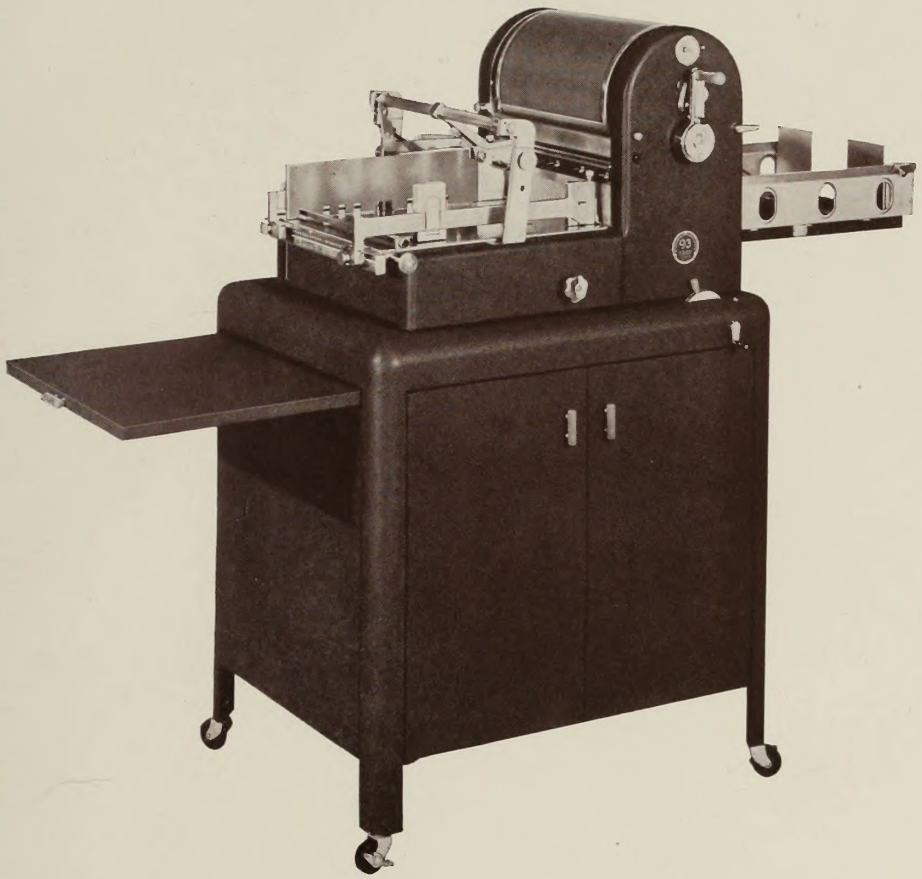
Trade-mark of A. B. Dick Company

Form 1.3495—2-46

Copyright 1940, A. B. Dick Company

17-A.

MIMEOGRAPH* 93 DUPLICATOR



A Mimeograph duplicator with an extra large duplicating surface. Equipped with a closed cylinder. Maximum duplicating surface, 11 x 17 inches. Accurate automatic feed with push-button start and stop. Feed-table, ream capacity (not to exceed 500 sheets of suitable Substance 20 impression paper or equivalent thickness in heavier weights), and will automatically feed impression paper of ordinary finish and furnish Substance 20 or heavier. Will handle impression paper up to 12 x 18 inches. Feed-table adjustments which include fine marginal adjustments and parallel movement of feed-table. Buckle adjustment for maintaining registration. Recorder (recording only copies) shuts off the feed at end of run. Feed shuts off automatically for reloading. Adjustments for positioning copy on paper without disturbing stencil. Receiving tray stacks 500 copies. Centralized oiling system for lubricating main bearings. Variable speed control motor drive, with speed range approximately 35 to 110 copies per minute. Safety connecting-link control between motor switch and crank handle. Free-wheeling clutch mechanism. Equipped with a reliable motor and an improved motor drive.

A. B. DICK COMPANY • GENERAL OFFICES, CHICAGO 6, ILLINOIS

*Trade-mark of A. B. Dick Company

Form 1.3493—1-46

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Hard-to-get Facts Made Easy-to-get —For Many People—Simultaneously

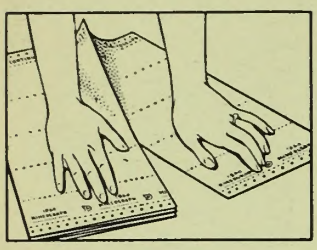
Now you can extend the usefulness of your IBM accounting machine. Tabulations needed for quick, accurate decisions and actions can be stencilized on your accounting machine, reproduced on your Mimeograph duplicator and distributed simultaneously to any or all department heads or individuals in your organization.

With this combination you can speed distribution of BILLS OF MATERIAL, PARTS LISTS, ASSEMBLY LISTS, PROCESS ROUTING SHEETS, INVENTORY CONTROL RECORDS, SHIPPING AND BILLING PAPER-WORK, SPARE PARTS LISTS, PROGRESS REPORTS, GENERAL STATISTICAL REPORTS, MATERIAL CONTROL RECORDS, MACHINE LOAD REPORTS, ETC. For information about these or other possible uses in your office write or telephone your nearest Mimeograph representative.

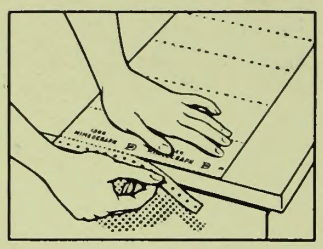
A. B. DICK COMPANY, CHICAGO 6, ILLINOIS

Form 1.3274—2-45

Seventh Step — SEPARATING STENCILS AND REMOVING TEAR-OFF STRIP



1 To separate individual stencils, lay the pack of stencils on a flat surface with one stencil unfolded; tear it off at the fold as shown.



2 Crease the bottom tear-off strip along perforation; then remove it by tearing downward against a sharp, square edge as illustrated.

Eighth Step — THREE DIFFERENT DEVICES AVAILABLE FOR ATTACHING STENCILS TO MIMEOGRAPH DUPLICATORS

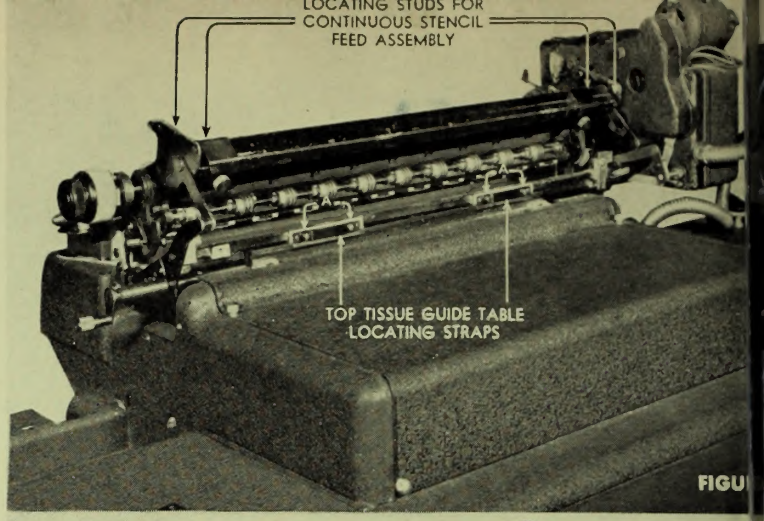
1 If a substantial number of stencils are attached daily to a Mimeograph 90 or 92 duplicator, greater ease and speed are made possible by installing the Mimeograph universal stencil clamp (Part No. 34500) and stencil transfer device (Part No. 33700) pictured on the back page of this booklet.

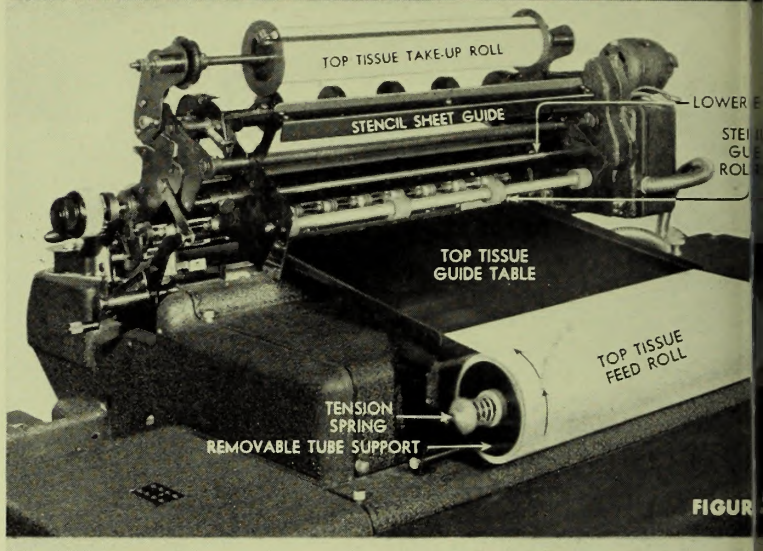
2 For smaller volume, adapter hooks, mentioned below, may readily be attached to the stencil stub hook bar of the regular stencil clamp:

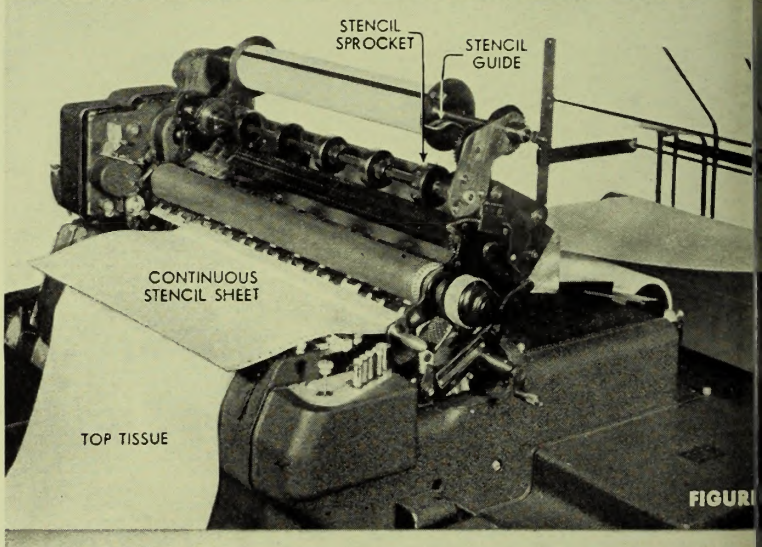
a For the Mimeograph 90 duplicator, Mimeograph adapter hook No. 40404 is required.

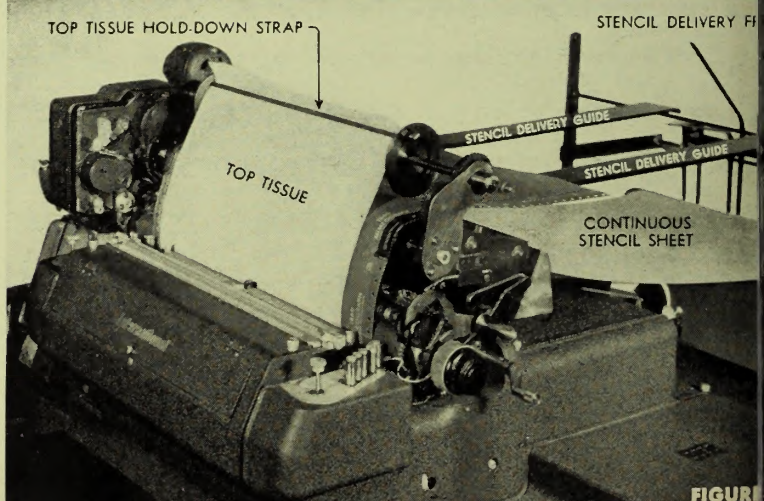
b For Mimeograph duplicators 77, 78, 91, 92, 96 and 100, equipped with CLOSED cylinders, Mimeograph adapter hook No. 40401 is required.

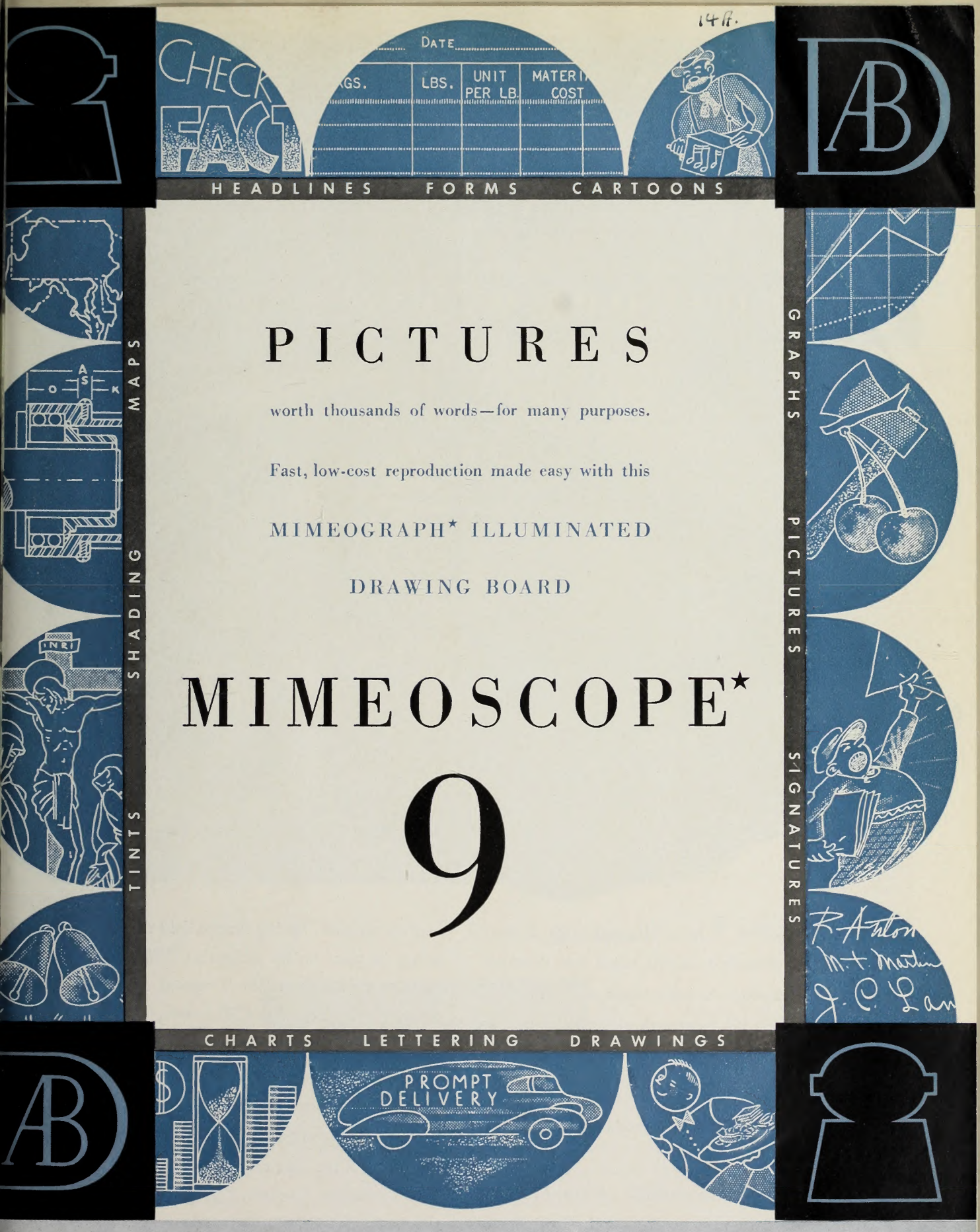
3 Stencils are attached to the adapter hook by placing holes at upper end of stencil over the three hooks on the adapter bar and clamping upper and lower ends of the stencil in the usual way.











PICTURES

worth thousands of words—for many purposes.

Fast, low-cost reproduction made easy with this

MIMEOGRAPH* ILLUMINATED

DRAWING BOARD

MIMEOSCOPE*

9

*Trade-mark registered in U. S. Patent Office

A·B·DICK COMPANY·CHICAGO 6

Copyright 1945, A. B. Dick Company

Branches and distributors in principal cities

BRIGHT, AIR-COOLED LIGHT

softly diffused over entire drawing surface

MAKES TRACING EASY

Mimeograph illuminated drawing board

MIMEOSCOPE 9



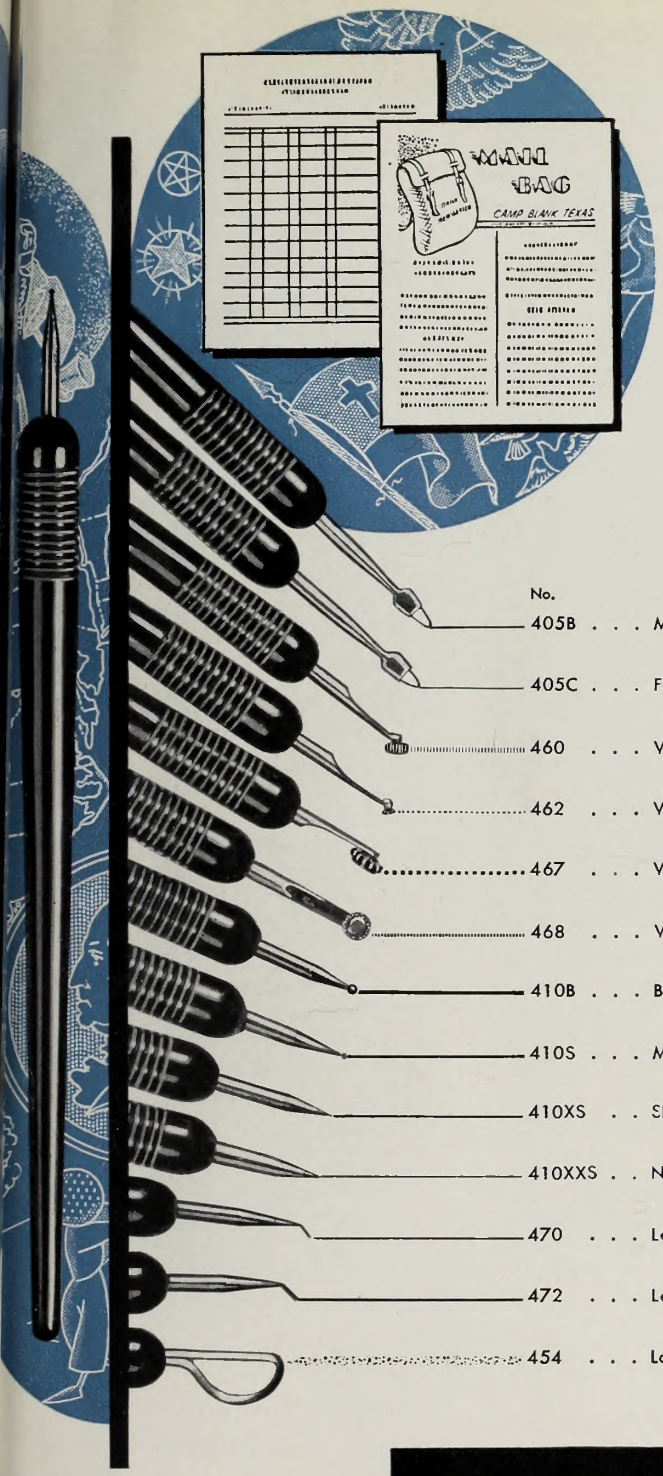
MIMEOSCOPE 9 is a Mimeograph brand illuminated drawing board used for tracing forms, line drawings, illustrations and lettering on standard-size Mimeograph stencil sheets.

Lettering guides, styli and screen plates are helpful accessories. Typewriting may be added to the same stencil and the whole rapidly reproduced in quantity on the Mimeograph duplicator.

The opaque-glass surface affords a bright but soft, evenly diffused light with no glare and a low degree of glass warmth. Spring clamps hold the stencil sheet firmly in place on its surface so that you can draw and letter with ease. The T square can be fastened across the surface of the Mimeoscope 9 horizontally or vertically—to draw accurate straight lines across or up-and-down the stencil sheet.

Included with the Mimeoscope 9 are a Mimeograph flexible writing plate No. 615, a Mimeograph stylus No. 405B, a ten-foot rubber electric cord with lamp socket and plug, T square, T square spring clamp, and the stencil sheet spring clamps.

Mimeograph and Mimeoscope are trade-marks of A. B. Dick Company



Mimeograph styli

For Ruled Forms, Lettering, Signatures

Mimeograph styli are pen-like instruments for stencilizing Mimeograph brand stencil sheets by hand. They may be used for free-hand drawing, ruling forms, shading, tracing, handwriting and lettering with Mimeograph lettering guides.
Uses and styles of stencilization are shown below.

No.	Description	Used for
405B	Medium loop	For general use, signatures, ruling, tracing drawings, etc.
405C	Fine loop	Far generol use, thinner lines and delicate ar detail tracings
460	Wheel	Gray-tone lines; ruled forms; large shoded areas
462	Wheel	Gray-tone lines; ruled forms and trocing drawings
467	Wheel	Dotted lines; used far a voriety of form work
468	Wheel	Fine dotted lines; horizontal lines; ruled forms
410B	Blunt point	Fine screen plote work; with perforating silk for heavy lines
410S	Medium point	Medium stylus far tracing outlines
410XS	Sharp point	Signatures, free-hand music, shorthand, maps, tracings
410XXS	Needle point	Small, delicate, for detail work. Far artists' use
470	Lettering guide	Far guides 846, 846-L and all with characters under 3/8 inch
472	Lettering guide	For guides with characters 3/8 inch or over, except 846 and 846-L
454	Loop	Far use with screen plates

Order by number to avaid mistakes.

Mimeograph screen plates

All plates are 3 inches square.

Various shading effects like those in newspapers and magazines are produced with translucent Mimeograph screen plates . . . used singly or in combination. Easy to use. They add eye-appeal to line drawings.

Mimeograph screen plates are thin, flat, hard-surfaced; each has a different pattern.

Place one under a stencil sheet. Rub over it with a Mimeograph screen plate stylus (listed above). The stencil is thus perforated with the pattern and will reproduce it in any desired area, attractively and easily.

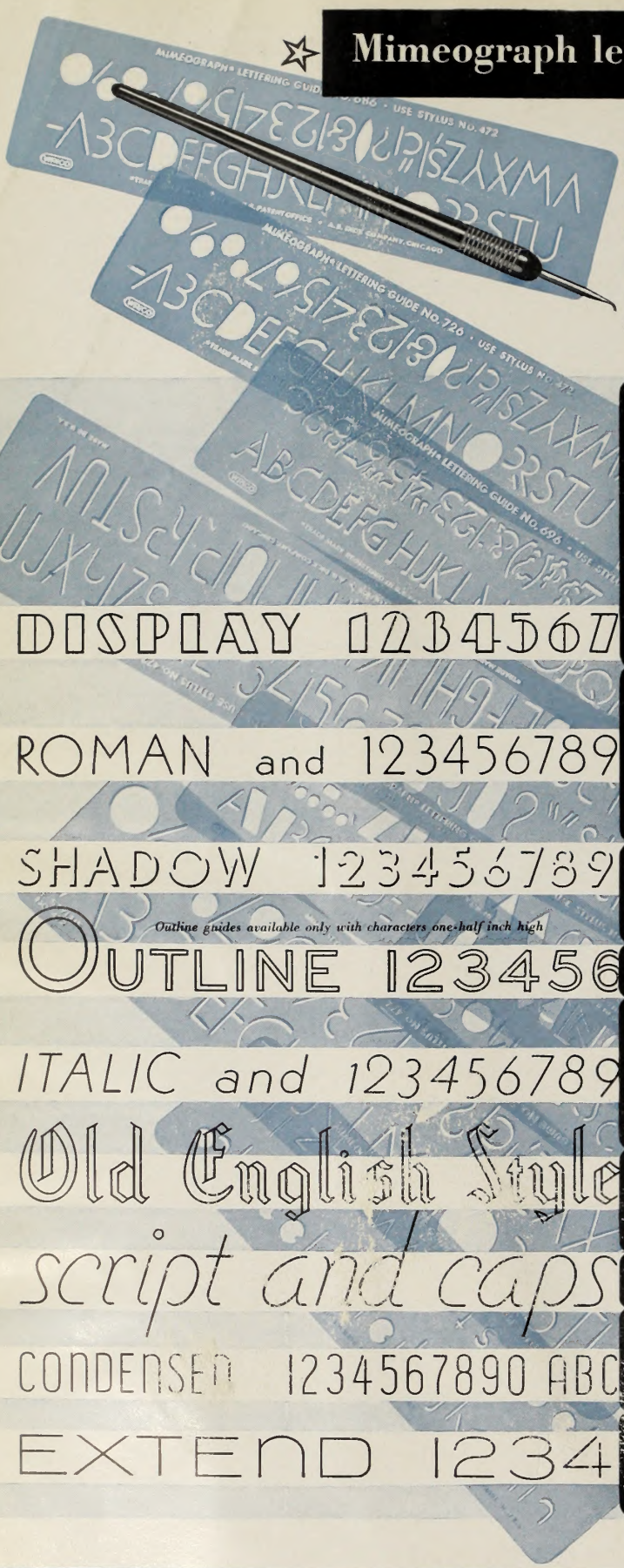
Tronslucent screen plotes Nos. 1627, 1642 and 1645.

Order by number to avoid mistakes.



Mimeograph and Mimeoscope are trade-marks of A. B. Dick Company

Mimeograph lettering guides

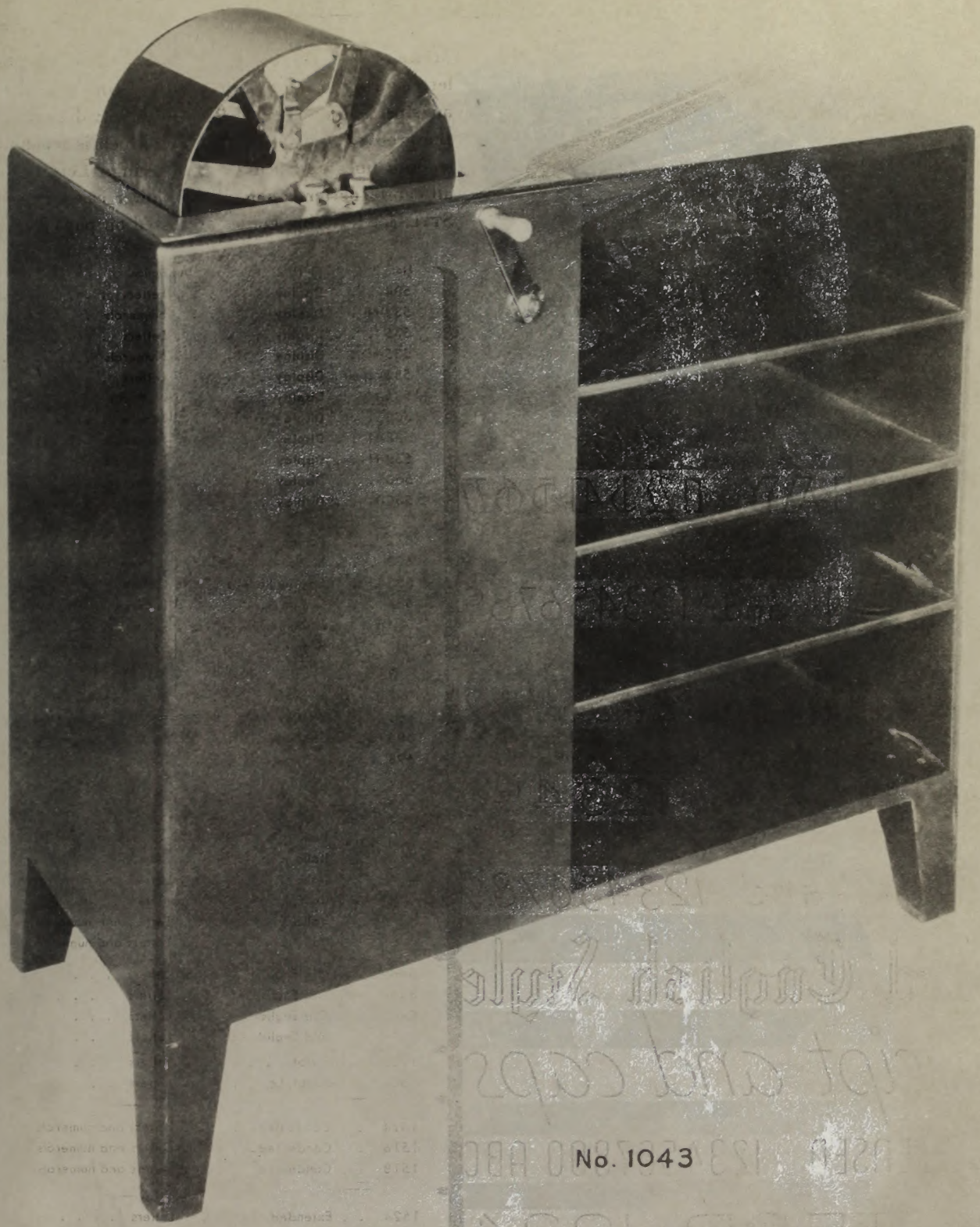


Mimeograph (Mimeostyle) lettering guides enable the user to letter on stencils for forms and bulletins with the precision of an expert. They are easy to use—simply draw a stylus through the grooves of a lettering guide, which is machined to assure smooth lines and attractive lettering. Letters on guides are all capital letters unless "l.c." (lower case) appears in listing. STYLI for lettering guides are listed on page 3.

No.	Description		Height Inches
534	Display	Letters	¼
534-N	Display	Numerals	¼
535	Display	Letters	⅜
535-N	Display	Numerals	⅜
536	Display	Letters	½
536-N	Display	Numerals	½
538	Display	Letters	¾
538-N	Display	Numerals	¾
539-N	Display	Numerals	1
550	Display	Letters	1 ¼
550-N	Display	Numerals	1 ¼
672	Roman	Letters and numerals	⅛
683	Raman	Letters and numerals	3/16
683-L	Roman, l.c.	Letters	3/16
684	Roman	Letters and numerals	¼
684-L	Raman, l.c.	Letters	¼
685	Raman	Letters and numerals	⅜
686	Roman	Letters and numerals	½
694	Shodow	Letters and numerals	¼
695	Shadow	Letters and numerals	⅜
696	Shadow	Letters and numerals	½
698	Shadow	Letters and numerals	¾
716	Outline	Letters	½
717	Outline	Numerals	½
722	Italic	Letters and numerals	⅛
723	Italic	Letters and numerals	3/16
724	Italic	Letters and numerals	¼
724-L	Italic, l.c.	Letters	¼
726	Itolic	Letters and numerals	½
728	Italic	Letters and numerals	¾
846	Old English	Letters	½
846-L	Old English, l.c.	Letters	½
848	Old English	Letters	¾
848-L	Old English, l.c.	Letters	¾
1508	Script	Letters	¾
1508-L	Script, l.c.	Letters	¾
1514	Condensed	Letters and numerals	¼
1516	Candensed	Letters and numerals	½
1518	Candensed	Letters and numerals	¾
1524	Extended	Letters	¼
1524-N	Extended	Numerals	¼
1526-N	Extended	Numerals	½

Order by number to avoid mistakes.

Form 1.3478—11-45—Printed in U.S.A.



No. 1043

Appendix B

Prices

The following retail prices of equipment were effective as of January 1,1947, anywhere in the United States, and are, of course, subject to change without notice.

Model 90	Mimeogrpah Duplicator	$133.13
" 91	" "	529.70
" 92	" "	633.00
	Interlayer	164.50
" 93	Mimeograph Duplicator	918.56
Stencil transfer device & universal clamp		82.43

The stencil sheet prices quoted below are taken from Price List form 2600 effective February 1,1947.

Mimeotype Stencils	Price
960	$3.50
961	3.35
96s	2.90
993	7.25
Cellotype Stencils	
1060k	2.85
1061k	2.70
1096k	2.35

Appendix B

Prices

The following retail prices of equipment were effective as of January 1,1947, anywhere in the United States, and are, of course, subject to change without notice.

Model 90	Mimeograph Duplicator	$125.15
" 91	" "	585.70
" 92	" "	655.00
	Interlayer	184.50
" 93	Mimeograph Duplicator	815.50
Stencil transfer device & universal clamp		36.45

The stencil sheet prices quoted below are taken from Price List form 5800 effective February 1,1947.

Mimeotype Stencils	Price
960 —	$5.50
961	3.35
965	3.50
965	7.25
Ditotype Stencils	
10B0K	3.35
10B1K	2.70
10B2K	2.25

Appendix B

For convenience in figuring costs in some of the cases to be discussed later, it might be well to break these figures down a little here. There are, of course, 24 sheets in a quire. That would make the cost of these stencils, per stencil sheet, as follows.

Number	Price per Sheet	Number	Price per Sheet
960	13.1 cents	1060k	10.8 cents
961	12.5 "	1061k	10.2 "
96s	11.4 "	1096k	8.9 "
993	27.5 "	1093k	23.5 "

When they are bought in quantity, the following discounts are applied.

Quantity In Quires	Discount
10	2½%
20	5%
50	7½%
100	10%

1089k and 1090k stubless stencil sheets are sold in packages of a thousand stencil sheets at the following prices.

Number	Price
1089k	$30.25
1090k	40.00

This means that the 1089k stencil sheets cost 3.025 cents a piece and the 1090k, 4 cents a piece. The quantity discounts on these two stencils are figured as follows.

Quantity In Packages of 1000	Discount
2 packages	2½%
4 "	5%
10 "	7½%
20 "	10%

Prices for 1060k2d and 1061k2d stencil sheets are as follows:

Number	Price per Quire	Price per Stencil Sheet
1060k2d	$5.70	$.23/2-3
1061k2d	5.40	.22½

The attachment for running continuous stencil sheets through the I.B.M. tabulator costs eighty-five dollars. The stencils sell for two dollars and seventy-five cents a quire. A roll of tissue paper which runs between the stencil and the type (to keep the type clean) also sells for two dollars and seventy-five cents.

The price of the stencil washing machine is three hundred and twenty-five dollars.

The price on each of the hard-set inks is two dollars and fifty cents a pound with the following quantity discounts in effect:

Number of Pounds	Discount
5	2½%
10	5%
20	7½%
40	10%

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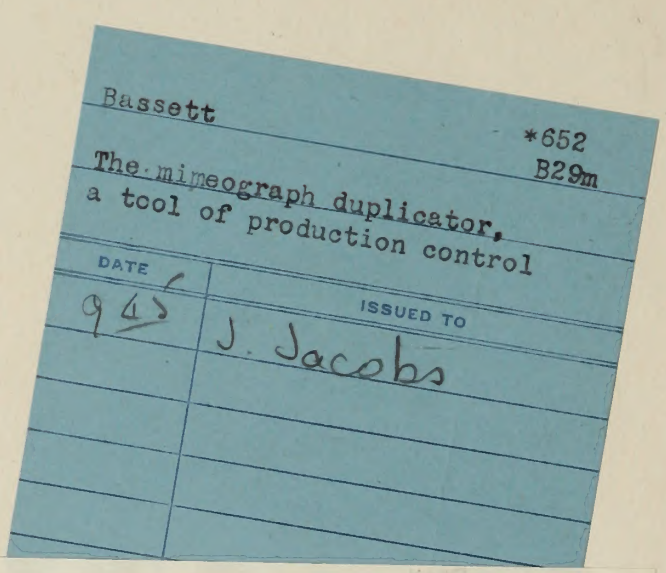
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The mimeograph duplicator,
a tool of production control
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